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Water Purification at Richmond

Description of supply and purification works for filtering and aerating river water. Uncovered clear-water basins satisfactory. Sulfite from pulp mills a serious factor in the purification process. Experiences in operation of plant

By Wellington Donaldson* and Frank O. Baldwin†

HISTORICAL

Until the end of 1909 the public water supply of Richmond, Va., taken from the James river, was distributed without any attempt at purification beyond that accomplished naturally by sedimentation and storage in the distributing reservoirs. On December 22, 1909, there were put in service purification works, comprising new intake arrangements, two subsiding basins of large capacity, two coagulating basins for clarification with alum, and a long flow line conduit to connect with the existing pumping station.

Provision was made for by-passing the river during muddy stages and drawing on the ample storage in the two subsiding basins until the river cleared up. The coagulating basins, of 15 m.g. capacity, were operated alternately on the fill-and-draw plan and were probably the foremost example of this method of operation in this country.

Application of liquid chlorine to the clarified water was started on August 3, 1914, at first with crude manual control and later replaced by automatic control

The above-mentioned purification facilities were used until August 29, 1924, when the filter plant was put in service. The results obtained during this 14-year period represented a great improvement over water previously furnished. Clarification and bacterial quality were generally satisfactory, but dissatisfaction arose on account of taste and odor, due mostly to microscopic organisms but to some extent to trade wastes. Increasing requirements of alum and chlorine, together with obvious limitations of the fill-and-draw method to meet increasing water consumption were additional factors in the decision to filter the supply.

PRESENT SUPPLY AND PURIFICATION WORKS

The water supply of Richmond is taken from the James river at a point near the westerly end of the city and some five miles distant from the business center. The river is divided at this point into two channels by Williams Island. Across the northerly channel is a concrete diversion dam 7 feet high and

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FIG. 6—AERATOR CONSISTING OF A BATTERY OF 300 SPRAY NOZZLES, WITH HALF THE NOZZLES IN SERVICE

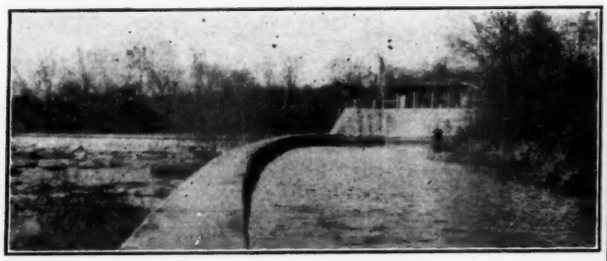

FIG. 1—DIVERSION DAM (LEFT), HEAD GATES AND DIVERSION CANAL (RIGHT)

FIG. 2—CONTROL WORKS AT LOWER END OF DIVERSION CANAL
In the background are the two sedimentation basins

400 feet long. Head gates control the entry of river water into a diversion canal some 1.600 feet long which delivers the river water to the sedimentation basins. Across the southerly channel of the river at Williams Island it has been found necessary to construct a loose rubble dike to maintain the river level during low water flow.

At the lower end of the diversion canal is another set of control works, shown in Fig. 2, by which water may be wasted into the river or diverted into one or both of the two sedimentation basins. The sedimentation basins, about a mile in length with a maximum width of 760 feet, are crescentic in plan and formed by rip-rap earth embankments. They have a capacity of aproximately 85 million gallons each and may be operated singly or in parallel. Usually, however, only one is used at a time on account of the liability of algae growths, thus giving a retention period of some four to five days at the average rate of consumption. The structures above described are all of 1905-06 construction, the use of which was delayed three years on account of construction, failure and repairs to the 50-inch flow-line conduit leading to pumping station.

The filter plant with its related structures and coagulating basins, built in 1922-24, is located in the two former fill-and-draw coagulating basins, making use as much as possible of the old walls and floors. The relation of new to old work is shown in plan by Fig. 3. This location was chosen because of the close limitations of head available for gravity operation, the limitation of funds available for a plant of 30 m.g.d. capacity, and the desirability of keeping functional the greater portion of the old clarification works which cost some $640,000.

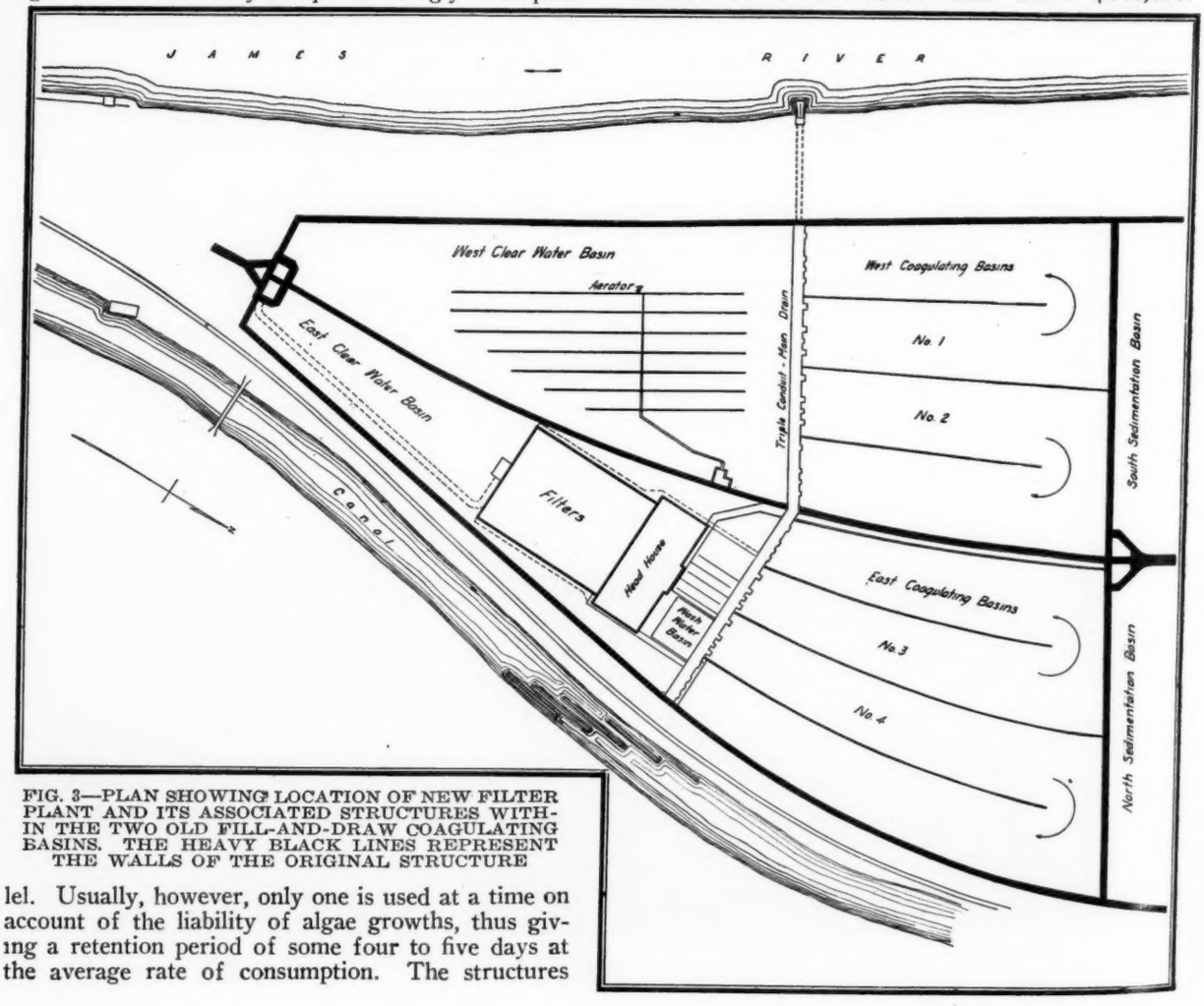

FIG. 3—PLAN SHOWING LOCATION OF NEW FILTER PLANT AND ITS ASSOCIATED STRUCTURES WITHIN THE TWO OLD FILL-AND-DRAW COAGULATING BASINS. THE HEAVY BLACK LINES REPRESENT THE WALLS OF THE ORIGINAL STRUCTURE

From the lower end of the two old subsiding basins water is taken by means of a new raw water flume to the filter plant, as shown in Fig 4. After addition of coagulant the water passes through a venturi meter into a baffled around-the-end type of mixing chamber designed for a retention period of 10 minutes at full capacity of 30 m.g.d. From the mixing chamber, water is carried by the triple conduit and distributed to the new coagulating basins consisting of four units operated singly or in parallel to give a retention period of 3, 6, 9, or 12 hours as desired. The effluent from the coagulating basins is collected again into the triple conduit and is then carried to the filters through two parallel lines along the outside of the filter building, entering each filter through the rear end instead of from a single pipe in the central gallery as is customary.

There are ten rapid filters of conventional design, except as to influent arrangement just noted. Each filter unit has a net sand area of 1,078 sq. ft., and a nominal capacity of 3.0 m.g.d. The filter underdrains consist of perforated cast iron laterals with brass eyelet orifices crimped in place, the laterals being connected to tees supplied by riser pipes from concrete conduits underneath the filter bottoms. Around and above the lateral pipes are 16 inches of graded gravel in five layers varying from 2½-inch to 10 mesh size. There are 27 inches of sand having a specified effective size of 0.38 to 0.45 mm. The filter "free board," or sand-to-gutter distance was originally 23 inches. The filter controllers and gages are of Builders Iron Foundry make and the controller rates are adjustable from the tables. The operating tables, shown in Fig. 5, are of the usual marble construction. Besides the hydraulic valve controls, they mount a combination rate-of-flow indicator, loss-of-head indicator, and loss-of-head recorder (7-day chart); also a switch for three pendant lights over the individual filters.

Under the filters is a small clear well. From the clear well the filtered water is delivered to the open filtered water storage basins represented by that portion of the former fill-and-draw coagulating basins not occupied by the filter plant structures. During gravity operation this storage of filtered water amounts to about 3 m.g. with a depth of 4 ft., but by pumping may be increased to 7.5 m.g.

Adjoining the filter super-structure is the head house, containing on the upper floor the chemical storage and a rectangular reinforced concrete wash-water tank. On the main floor are the office of the supervising chemist, laboratories, store rooms, chemical feed machines and chlorine room. For chemical feeding there are six machines of the Gaunt type, direct connected to individual motor drive, two each for alum, lime and soda ash. Each machine is equipped with revolution counter for logging the operation. For distributing the chemical solution to various points there are special distributing boxes of concrete having plug valves and proportional weirs to obviate a multiplicity of valves ordinarily used for cross connections. Alum may be applied through duplicate rubber hose lines to the inlet of the mixing chamber or to the two applied water conduits. Soda can be fed to the clear well underneath the filters or to the effluent flume leading to the pumping station, in case it should be desired to correct corrosive tendencies of the water.

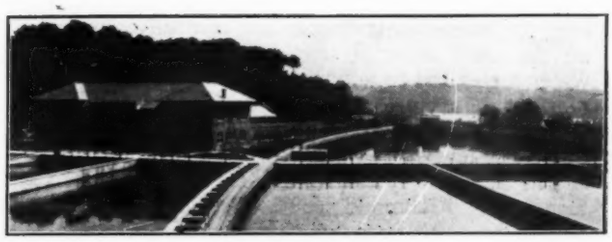

FIG. 4—FILTER PLANT CONSTRUCTED WITHIN THE OLD COAGULATING BASINS

Latticed structure in foreground is new raw water flume following along old division wall. The transverse wall contains the triple conduit

The chlorine equipment, consisting of two W & T. vacuum type machines, is housed in a separate room with ventilating fan. The machines are arranged to feed either to the clear water underneath the filters or to the effluent flume leaving the plant.

In the basement of the head house are four motor-driven pumps, two of 20 mgd. and two of 10 mgd. capacity, designed for two-speed operation. These pumps are used when the aerators are in service or when it is desired to utilize the full storage in the filtered water basins. In the basement there is also an automatic motor-driven wash-water pump taking suction from the clear well and delivering to the concrete tank on the top floor. On account of the limiting elevations it was necessary to provide a retention basin of 100,000 gallons capacity for the waste water from the plant during times of exceptionally high water in the river. For emptying this basin at intervals between filter washings, an automatic motor-driven pump is provided in the basement of the head house.

The filter plant is well metered. In addition to the flow indicators of the individual filters, there is a 48-inch by 30-inch venturi on the raw influent to mixing chamber, and a 60-inch by 30-inch venturi on the effluent conduit leaving the filtered water storage. There is a venturi on the wash-water line betwen tanks and filters. For convenience in read-

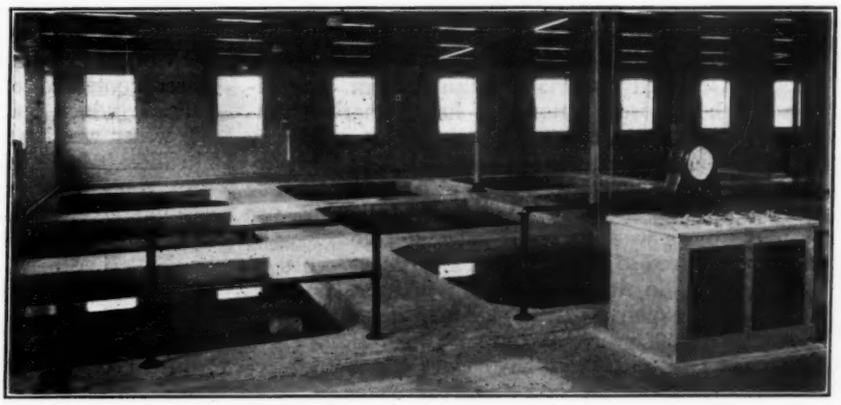

FIG. 5—VIEW OF ONE OF THE FILTER UNITS WITH ITS OPERATING TABLE

ing, the meter instruments are centrally assembled on the main floor of the head house. The wash-water meter has in addition an illuminated extension dial visible from all parts of the filter room. Indicating or recording gages are provided for the various basin levels.

The aeration system is a somewhat unusual feature of the Richmond plant. Previous troublesome experience with tastes and odors indicated the need of more efficient aeration than is ordinarily provided. The aerator shown in operation in Fig. 6 consists of a grid system of cast iron piping supported on the floor of the westerly clear water basin. There are seven parallel rows of 10-inch cast iron pipe, spaced 20 feet apart. Each of these pipes is tapped at 6 ft. intervals by 2½-inch riser pipes surmounted by brass spray nozzles of the Binks type. There are 300 such nozzles in the entire battery Each nozzle has a rated delivery of 70 g.p.m. at 5 lbs. pressure. The last three lines of manifold piping are controlled by hydraulically operated valves from floor stands on the adjacent basin walkways so as to take care of the variations in pumping. This arrangement allows 50 or 100 or 150 nozzles to be taken out of service.

From the second compartment of the clear water storage the filtered water flows through the old 54-inch concrete conduit some 5,000 feet in length, which follows along the river bank to the pumping station. It is then lifted to uncovered twin distributing reservoirs in Byrd Park and a portion is repumped by a booster station to reach the high service district. Approximately 66 per cent of the daily consumption is thus repumped.

OPERATING EXPERIENCES

The operating experiences since the plant was put in service nearly three years ago are of some interest. The James river varies in turbidity from 0 to 1,500 ppm., while the color ranges from 6 to a maximum of 80 ppm. The alkalinity varies from 4 to 80 ppm. and the total hardness from 9 to 130 ppm. Sewage pollution of the river is not a serious factor, as the principal sewered communities on the watershed are some distance up-stream, while the contributing population is not great in proportion to the diluting capacity of the river. Pollution by sulfite wastes from pulp and paper mills on the head waters some 220 miles up-stream is, however, a dominant factor in the quality of the raw water and the purification treatment. During low stages of the river the sulfite waste markedly affects coagulation of water and is responsible for large increased doses of both alum and chlorine. The efficiency of the filter units is impaired by a sticky, discolored material resulting from coagulation of the colored water. It has a marked tendency to encrust the sand, which makes necessary its treatment at six-month intervals with sodium hydroxide and sodium carbonate in the filter. The "gumming" of the beds makes necessary the use of much more wash-water than would otherwise be usually required Taking all in all, the presence of sulfite wastes in the supply entails a very considerable annual expense to the city and constitutes one of the principal problems of plant operation.

The mixing chambers have been found to serve an important function in getting the water properly coagulated. With flows of less than two-thirds the rated capacity of the plant, however, it has been found that action in the mixing chamber is impaired, due to the lowered velocity and tendency to deposit in the chamber. This has been overcome by intermittent admission of raw water.

With four coagulating basins operated in parallel, there is unusual flexibility as to retention period. In general it has been found that with water containing sulfite waste the full retention period is advantageous but with turbid water less than the full coagulating basin capacity is needed.

There has been little trouble with the filters aside from that mentioned above in connection with sulfite wastes. It has been customary to scrape the beds about once a month. In some instances dead spots have been found but were easily removed without putting the filters out of service. Effective size and uniformity co-efficient are within the original specifications.

Filtration alone without aeration has corrected most of the trouble formerly experienced on account of tastes and odors, and during the first two years of operation the aerators were little used However, the practice now is to operate the aerators continually during the nine warmer months of the year as it has been found that the water is made more palatable thereby, and corrosive tendencies are reduced through the removal of 35 to 75 per cent of the CO_2. Few complaints are received about taste and odor and very few due to corrosion trouble.

It has been found advantageous to apply chlorine in two doses to the filtered water, first in the clear well under the filters and, secondly, to the effluent conduit leading from the plant. There is some loss of the first dose of chlorine by aeration but sufficient residual is maintained in the clear water storage to prevent growths of algae which would otherwise occur in the brilliantly clear water exposed in a thin layer 4 to 6 ft. deep, in an open basin of such large area. The only alga noticed so far is Cosmarium which occurs in a few thin, bright green patches on the basin floor in spite of the presence of a slight residual chlorine, but this growth has never been in amount sufficient to be objectionable. The local experience discounts somewhat the prevailing view that all clear water basins must necessarily be covered to keep down algae growths. The primary chlorine dose averages about 0.36 ppm., which leaves a residual of .06 ppm. after passage through the two filtered water storage basins. The secondary dose of about 0.30 ppm. is then added as an additional safeguard

Prior to installation of the filters, the distributed water contained considerable amounts of colloidal alumina which later precipitated, particularly when the water was heated. With proper coagulation and filtration it has since disappeared. The daily laboratory routine includes tests for residual alumina in the filtered water and this test has been found very helpful as a check on coagulation and filter behavior. The method used is a colorimetric one developed in the local laboratory, as described by Baldwin in the Journal of the A. W .W. A., Vol. 12, pages 439-40, 1924 The method is a modification of Atack's method but using permanent standards for matching. It is sensitive to .02 ppm. Al_2O_3.

Values obtained from the filtered water have ranged from .02 to 0.35 ppm. If the value exceeds 0.10 ppm. it is considered indicative of improper coagulation. The test requires only ten minutes to complete.

Some experiments have recently been made with sodium aluminate solution, in connection with alum, for coagulating the water but the results are as yet indeterminate. In regular operation, only alum in powdered form has been used for coagulation. It has not been found necessary to apply soda ash to the raw water, nor lime to the filtered water.

The large subsiding basins as a step in the purification process are of questionable value under present conditions. When first installed they were no doubt helpful in aiding clarification, but recent experience indicates that the ample coagulating basins alone are capable of taking care of the worst turbidity of the river. The original assumption that the intake would be used selectively to reject river water during the very turbid stages of short duration, while drawing on the large storage in the subsiding

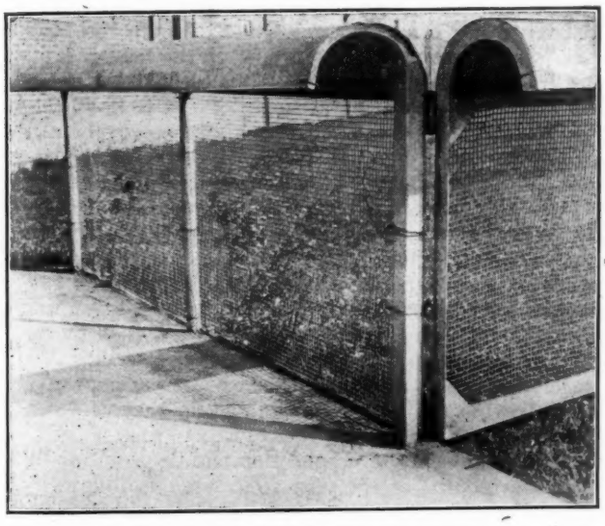

FIG. 7—FROG FENCE AROUND FILTERED WATER STORAGE BASIN

basins, has not been found of practical value within recent years. The head gates being more than a mile distant from the plant makes their manipulation impracticable. As a matter of fact, the prolonged storage in the two large subsiding basins in this climate provides opportunity for very troublesome growths of algae such as Anabaena, and during such periods the use of the large basins is disadvantageous as compared with a direct river intake.

Considerable annoyance was formerly experienced on account of toads, frogs and snakes finding their way into the clear water basin, and as a preventative a special fence has been constructed around the filtered water storage basin. The fence consists of ¼-inch mesh galvanized wire, 30 inches high attached to 1¼-inch G. I. pipe supports, spaced 5 ft. apart, and surmounted by a curved strip of galvanized sheet iron .025-inch thick, curving outward as shown in Figure 7. This fence has been successful in preventing access of these undesirable animal forms.

The principal operating results of the purification works during the year 1926 are given below:

Water treated, M.G.D.	
Ave.	19.68
Max.	27.92
Min.	11.24
Alum dose, g.p.g.	
Ave.	2.92
Max.	6.08
Min.	1.23
Chlorine dose, lbs. mil. gals.	
Ave.	6.72
Max.	9.96
Min.	4.68
Filters, Ave.	
Units washed daily	4.33
Wash-water per unit, thousand gals.	70.
Wash-water, per cent of filtered	1.57
Final loss-of-head, Ft.	4.4
Filter runs, hours	
Ave.	37.9
Max.	93.4
Min.	7.1
Turbidity, ppm.	
River	93.
Settled (a)	79.
Applied	1.
Color, ppm.	
River	38.
Settled (a)	30.
Filtered	2.
Oxygen consumed, ppm.	
River	9.45
Filered	3.30
Bacteria at 37°	
River	1740.
Settled (a)	640.
Finished	4.0
B. coli per 100 cc.	
River	508.
Finished (b)	0.025

(a) Plain Subsidence, before addition of coagulant.
(b) Only two positive tests out of 772 standard 10cc. portions examined.

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Street Department Distributes Flower Boxes

In a discussion recently on the services rendered by a street department, W. J. Galligan, assistant superintendent of the Bureau of Streets of Chicago, told of an unusual service rendered by the department of that city. It seems that a women's club, in endeavoring to improve the conditions of some of the slum sections, desired to distribute window boxes, selling them at a price that even the poorest families could afford. The plan seemed about to fall through however, because of the cost of delivery. The street department found that one of the firms that could manufacture these window boxes would deliver them at a point from which they could be hauled to the section under consideration by the teams of the department. Arrangement was made to do this and the boxes were filled with black earth and delivered into the homes of those desiring them for the sum of 15c a piece. By consent of the Board of Education, the teachers canvassed the different rooms in the public school and took orders for the window boxes and turned the orders into the ward office, where

they were segregated into rubbish districts and the following morning rubbish wagons otherwise empty left the stables carrying the flower boxes and returned with their customary loads of rubbish. In that year more than 700 of these window boxes were distributed in this way.

Garbage Collection in Norfolk*

Records aid in collector assignments. Increase in personal efficiency and in equipment effect economy

By Walter H. Taylor†

Shortly after taking charge of the street cleaning force in the city of Norfolk, I had a check made of every piece of equipment leaving and arriving at the stables. Each cart, wagon, trailer and truck was traced through the day's work, the number of stops of each vehicle made, as well as the packages collected was recorded. The number of stores and apartment houses were listed separately from each house. The time consumed in collecting loads and in driving to the dump and returning to district was also taken. This record made and tabulated resulted in a far more equitable distribution of the task in hand and results obtained were very gratifying.

Likewise the route of each street sweeper and the territory covered by each "white wing" was carefully checked and studied, some added to, some taken from and the schedule of all forces both night and day made upon a basis of eight hours work per day. The figures hereinafter mentioned cover not only collections of refuse and garbage but of all street cleaning operation.

The city of Norfolk has been fortunate in its development in having near its geographical center an industrial area in the midst of which we have been able to maintain incinerators. These incinerators, three in number, have destroyed a large portion of the garbage collected and in a manner leaving little to be desired. I cannot recall having received a complaint for several years back regarding these operations.

For collections the city is divided into two sections and in each section subdivisions are regulated and supervised by foremen. Collections in the business area are made daily, elsewhere in the city on alternate days. Of course the quantities vary from day to day and by means of frequent reports over the telephone to the central office the progress in each and every district within the city is noted. In case of unusual quantities being found in any one locality equipment is sent from the district furthest advanced in its operations to the district behind. By a spirit of co-operation between the foremen, we have in this manner been able to reduce expenses and increase the efficiency of the department.

During the year 1922 the area of the city was approximately ten square miles and the appropriation made for garbage collections and refuse collections including all street cleaning was $330,000. During the past year notwithstanding the fact that the city has been increased from ten to thirty-eight square miles and the population increased from 125,000 to 175,000, our appropriation for the Street Cleaning Department was $50,000 less than in 1920.

This result has been brought about, in part, by the hereinbefore mentioned increase in efficiency in the personal service and by the introduction of motor drawn equipment, trailers drawn by tractors being an important factor in results obtained.

In the congested down town district where the lanes as well as the streets are narrow, we still use wagons or trailers hauled by horses or mules. As we leave the business center we find trucks, then tractors and trailers, most serviceable. In some sections large trucks for the ashes and refuse, haul trailers for garbage. In other sections we have tractors with as many as three trailers. Garbage in all cases is separated from other collections.

Whereas we have not adopted generally the system of "spotting" trailers, we have succeeded in using this method in a small way both with garbage collections and refuse collections. The tractors carry empties to designated points and pick up the loaded trailers, which loaded trailers may be destined for either disposal dump or incinerator.

In addition to the separations above noted, the city ordinance requires all waste paper to be bundled to prevent being scattered by the wind. In large areas of the city, collections of waste paper are made by specially built wagons. When the market warrants the sale of same, we deliver to dealers engaged in this trade, otherwise paper is used as fuel in burning garbage. Ashes, street sweepings, etc., are used in filling low areas within the city, mostly areas owned by the city, otherwise a charge is made for the service. We receive either so much per load upon a yardage basis or following the completion of the fill receive a certain per cent. of the land involved.

The average costs of collection and disposal for the first six months of the year 1926 were as follows:

	Quantity	Cost per cu. yd. Collection	Disposal	Total
Refuse & misc.....	68,697	$0.6270	$0.0283	$0.6553
Garbage	13,727	1.0850	0.4000	1.4850
Paper	27,769	0.4061		0.4061
Sweepings	16,391	0.8300	0.0283	0.8583

W. G. Mitchell, superintendent, is in charge of the operations of the department assisted by C. W. Armstrong, and reports direct to the writer.

*Paper before the International Association of Street Sanitation Officials.

†Director of Public Works, Norfolk, Va.

Underground Removal of Refuse

In a discussion before the (English) Institution of Sanitary Engineers on the collection of house refuse, C. H. Gentry said that he hoped the time would come when all household refuse would be removed underground by means of air, as sewage is now removed underground by means of water.

Perhaps. Pneumatic transportation underground is very expensive now; but citizens should be willing to pay something to avoid the dust, odors and other nuisances created by present methods. It is a common statement that collection of refuse has not made as much progress as has disposal, of recent years and some radical improvement along this line is about due.

The Pavement Base Situation*

Causes of failures of concrete bases discussed. Preparation of subgrade. Faulty concrete due to poor material, hasty mixing, poor workmanship, excess of water, ignorance or collusion—seldom the last. Increased richness, thickness and reinforcement

By J. H. Neeson†

Complaints in regard to street conditions in Philadelphia date back to 1705. In 1720, an ordinance was recommended "to restrain the weight of loaded carriages passing over the pavement." A lottery in 1768 provided five thousand pounds for paving streets and making other improvements. An ordinance introduced in 1854 provided for paving with dressed stone, cobble being the prevailing type before this date. Thirty-seven years later the use of concrete base was recommended; the history of permanent pavements begins with 1892-93. However, the city found itself in 1919 with pavements inadequate both in quality and quantity.

It is of interest to determine to what agency or agencies can be attributed the failure of pavement bases in streets since 1912, when the Bureau of Highways was placed on an engineering basis and its specifications standardized. For the purposes of discussion, we may discriminate between streets occupied by railway tracks, and those not so occupied. Since the underlying causes of failure may be and are different, we have confined the discussion to streets on which there are no street railway tracks.

Failures of concrete base can be attributed to any one or to a combination of the following causes:

(a) Inadequate preparation of subgrade;

(b) Imperfect and improper replacement of ditches and service cuts;

(c) Inferior concrete;

(d) Inability or failure of the top surface to perform its proper function.

In our judgment, too much stress cannot be laid on the necessity of properly preparing the subgrade for the concrete foundation if it is to be expected to accept the uniform distribution of the loads applied to it directly or transmitted through the base foundation. Particular care should be given to this feature of the construction, not only prior to the placing of concrete but during that operation. The existence of any soft, spongy, or loosely bound areas will be as fatal to the life of the concrete base as fill in trenches opened for underground services in neglect to replace in the most efficient manner the advance of the paving or in checking up on older cuts. Lack of the fullest recognition of these important factors has contributed to the failure of street paving in this city and elsewhere.

In an effort to remedy these causes of defects we have recently included in our specifications the clauses that all backfill in open or recently refilled ditches, whether high or low, must be replaced by mechanical tamping. This is intended to cover also those areas of subgrade found to be insufficient to withstand the strain of applied rolling loads.

In practically all contracts for paving or repaving the engineer must contend at some time or other with a condition known as wet subgrade, a difficult feature to control. Much reliance has to be placed upon the judgment of the engineer and the inspectors in charge of the work; hence the human element enters into the determination of fitness or unfitness of the subgrade. The tendency, which is natural, is to proceed with the placing of concrete in order not to delay the progress of the work or, perhaps, to anticipate another change in climatic conditions. It should be an elementary rule in good construction work to make an interruption at this point if it is to be considered of prime importance that the subgrade shall be thoroughly dried out. No criticism can be directed either at the contractor or the engineering forces for this character of delay, even though by taking chances the work could be expedited. The added insurance of competent paving work should be a sufficient offsetting influence against a desire to secure quantity at the sacrifice of quality performance.

It would seem there should be no disagreement regarding the most vital element entering into street paving construction—the preparation and placing of the concrete foundation. Engineers, laboratory workers, and chemical analysts have concentrated their efforts upon the values of mixes and aggregates that enter into the composition of concrete. But we still find evidence of paving failures traceable to base deterioration. If, as has been established by years of experimentation, pre-cast concrete specimens of given depth and diameter do withstand minimum breaking loads per square inch of bearing surface, should such failure be attributed to the known and accepted traffic loads of today? It is, at least, questionable. The debatable accuracy of physical tests of poured concrete as now generally made results in none too dependable classification and is frequently misleading in showing abnormally wide ranges of values in one operation, thus leaving the matter open to a number of conjectures. There is need for more accurate and satisfactory methods in physical tests of set-up concrete in place, tests that will more reasonably determine at once the worth of the slab without resort to chemical analysis except as routine check-up. Attention being directed to the modulus of rupture theory in slab or base concrete through work being done by the State Department and by other testing engineers, may result in the abandonment of present practice. But if the physical laboratory test does show beyond question of doubt that the concrete specimen breaks at or below the minimum accepted requirements and chemical analysis indicates a lack of proper proportioning or the absence of cement and aggregates, we

*Abstract of paper before the Engineers' Club of Philadelphia.

†Chief, Philadelphia Bureau of Highways.

are face to face then with a serious defect and perhaps defection upon the part of those in responsible charge of the work.

How do such situations arise? Briefly, they may be summarized as due to inherent weakness of cement or of sand or gravel or stone; too hasty mixing; to poor workmanship in placing; to the excessive use of water; to ignorance or inexperience on the part of the inspector; and finally to deliberate collusion on the part of the inspector and the contractor or his representatives.

As a contribution to this discussion the Bureau of Highways within the last fifteen days has made examinations of pavements on eleven streets placed between the years 1913 and 1926, where we had reason to believe base failures might exist. A total of twenty-seven openings were made and it developed that in eight cases the failures were surface failures only and the base concrete was intact; failure in four other instances was found to be due to improper tamping of ditches in advance of placing concrete; three others were evidently caused by poor subgrade condition; in two instances the concrete base, laid in 1913, had been shattered and from our knowledge of traffic conditions over the street in question we judge this was due to impact transmitted through surface wear-outs, which the base was unable to withstand. We may state that, broadly speaking, ten of the twenty-seven openings made revealed evidence of poor concrete. Five of these locations were in one street of considerable length and while there were extenuating circumstances in the way of weather and grade conditions, we must reach the conclusion that in the particular locations opened the concrete was of an inferior quality, since on all sides of the opening the concrete was of good quality. Those spots that failed evidently were "lean" and caused by lack of cement or overloading of coarse aggregates, improper water content or too hasty mixing.

The conclusion is upon observation only, as no chemical or physical tests were made; no doubt one, or a number, or perhaps all of the factors enumerated entered into the disintegration of the base. The incident is brought forward here to illustrate the importance of the relationship between the municipality, the contractor and the inspector, and the necessity for intelligent co-operation. It has been the writer's experience that the great majority of responsible contractors do give a dollar's worth of work for the dollar received; and furthermore, only on rare occasions have we found an inspector who is willing to stand by and tacitly agree to a flagrant violation of the specifications. The first requisite of a good inspector is fidelity and loyalty to the responsibility imposed on him.

Rather than place too much emphasis on the lack of cement or disproportioning in cases not proven, our observation has been that in the effort of the contractor's organization to make yardage, there are occasions when good workmanship is sacrificed. Mechanical faults creep in. Water is, on occasion, too freely used with a consequent sloppy mix; the period of mixing is not given the attention it deserves—a fact that is quickly demonstrated in the looseness and raveling of the concrete in drying out.

A check-up on 60 per cent of the concrete in operation in the month of July, 1926, by an engineer observer of the Bureau showed that on one-half of these contracts insufficient attention was being paid to water content and the average time of mixing was about 45 seconds instead of 60 seconds as called for in the Philadelphia specifications. These conditions were corrected immediately. Assuming that all the necessary quantities of ingredients have been used and in the proper proportion, the strength value of concrete depends almost entirely upon the mechanics of mixing and placing. The time element can be controlled readily and the specifications of the Bureau of Highways for 1927 do not permit the use of a mixer not equipped with a timing device. The variation in time of mixing in ten other cities is illustrative of the differences of opinion of specification makers: New York, Washington, Detroit, Cleveland and Baltimore require the same period as Philadelphia—60 seconds; Chicago, 50 seconds; Boston and Newark, not specified; while Pittsburgh and Buffalo represent the extremes—90 and 38 seconds, respectively.

As in the case of timing, there is no common standard adopted by all of the eleven cities mentioned regarding the period of protection of new base from traffic. New York, Newark, Buffalo, Boston and Baltimore do not specify the number of days; Washington requires four; Chicago, Cleveland, Pittsburgh and Philadelphia call for seven; while Detroit seems to be taking extraordinary good care of newly laid foundation by putting up the bars against traffic for fourteen days. This feature seems to be either over or under-stressed; fitness to proceed has been regulated mainly by experience and judgment, without resort to any scientific principle. To the influence of climatic changes and speed may be charged reasonable doubt of the maturity of some of our base foundation, less important perhaps than other factors, nevertheless cumulative in the final analysis. Again the fixing of a water-cement ratio should be helpful in removing "greenness" or "ripeness" from the speculative field. The water-cement ratio, now featured in the discussion of concrete as an index to the ultimate value of concrete for plain foundation, ordinary building construction, or more intricate bridge work, may have an important function to perform in paving base of the future.

The increase in the volume, weight and speed of vehicular traffic, particularly motor trucks and buses, is bringing out more pointedly the close relationship existing between the wearing surface and base foundation. Modern traffic insists that the surface pavement perform an efficient manifold service—comfort, appearance and ease in cleaning, but shall be primarily an ample protective covering for the base. Satisfactory wearing surfaces for either economy or expediency have been practically reduced in many cities to two types, dressed granite block and asphalt. We have shown in the recent investigation that the disintegration of base concrete in two selected cases was due to the failure of the wearing surfaces. Every pot hole, depression or minor break not only is a potential menace but if allowed to go on without being repaired must eventually cause damage to the foundation from the impact of dropping loads. It

is obvious, then, that the wearing surface should be smooth and substantial; it will give service and function properly only in direct ratio to the attention it receives from the maintenance organization. Dressed granite block has shown most satisfactory results in serving modern requirements in this city and has afforded a sufficiently smooth running surface. It has been expedient and economical to use this type of surface in Philadelphia because of the large mileage of streets already covered with granite block on gravel base, permitting the redressing of selected block. With a high resistance to displacement and greater adaptability to uniform distribution of loads, we have found very little evidence of base disintegration under block, except that attributed to poor subgrade or in ditches and cuts replaced some time after repaving. We endeavor to repave in kind—block for block—but expediency also requires that in repaving programs a balance be maintained between block and asphalt, including sections of our main-travelled thoroughfares. Asphalt, although used exclusively on new paving operations, is less hardy than block and shows more quickly the devastating effect of heavy loads. In a greater measure than is the case with granite block, the life of the wearing surface is dependent upon prompt maintenance repairs, although in our investigation we found only two instances where disintegration or possible neglect in making prompt repair was the direct cause of shattering of base, But observation alone, irrespective of the type of wearing surface, will demonstrate the futility of preserving base without periodic maintenance patrol.

In the above survey we have endeavored to outline what appear to be the major causes for base failures, endeavoring to suggest the corrective measures that might be applied. It seems to be generally recognized, however, that a change may have to be effected in the character of concrete base or improved methods employed to guarantee against failure during normal life. The principal suggestions so far brought forward are an increase of two inches and upwards over the commonly accepted depth of six inches, strengthening of the mix and the resort to reinforcement. The last idea will not find favor in many municipalities, at least not until the day arrives when city streets are laid out boulevard fashion permitting the placing of all subsurface structures in the footways or allocated unpaved areas in the roadways. To a limited extent, placing of reinforcement in base foundation should receive serious consideration. The tendency of track structures, particularly intersection crossings, turnouts and switches, to cause paving defects and consequent irreparable damage to base concrete would seem to warrant in special cases of this kind the use of reinforcing material, not only to protect the base itself but the substructures passing underneath; otherwise, the necessity for intermittent opening up of street paving and the difficulty of replacement from the engineering standpoint does not appear to justify the increased cost of this type of construction. Not one of the eleven cities heretofore mentioned has adopted reinforcement in city street paving. The use of reinforcement may, however, shortly become desirable in the replacement of concrete over service cuts and ditches unless methods now employed to guarantee stability of the backfill prove to be more satisfactory than is now the case.

A richer mix, at increased initial cost, may indicate the trend of thought in some cities, as the following data show:

MIX PROPORTIONS.	
1:8	Buffalo
1:2:3 to 1:3:6	Chicago
1:6	Cleveland
1:2:4 to 1:3:6	New York
1:2:3:	Pittsburgh
1:2.5:4.5 (stone or gravel) and 1:2.5:4 (slag)	Detroit

Note: Compiled data quoted in this paper are subject to correction due to possible recent changes in specifications.

A survey of these eleven cities shows that to date only two, Buffalo and Detroit, have incorporated as a requirement of their specifications eight-inch concrete base; New York, Philadelphia, Pittsburgh, Washington and Newark still maintain the six-inch depth; Baltimore, four, five or six; Boston, Chicago Cleveland have specified no depth, evidently with the thought of meeting special or variable conditions. Nevertheless there is a growing disposition to believe that increased depth of base is the solution of the problem. It may or may not be. But in the belief that we must provide extra depth of base if we are to have future security in the soundness of our foundation paving, Philadelphia completed two major repaving projects in 1926, using eight-inch concrete base. One was in the water front section where traffic is not only congested but heavy, and the other on a heavily travelled truck, touring car and bus route. Experience has demonstrated, granting that all possible care has been taken in the preparation and placing of 6-inch foundation, that failures do occur. An increase in the factor of safety is inevitable and for that reason we believe we were fully justified in absorbing the additional cost on these operations.

As against these theories are the possibilities of improvements in the methods which may permit us to maintain a foundation of six-inch depth and one that will meet the test of heavy-duty traffic.

Any new proposition, involving other than minor changes in specifications, adds to capital expenditure per square yard. A mere increase of two inches in depth of 1:3.6 concrete on a city street, twenty-six feet in width between curbs will, at a conservative estimate, add $10,000 per mile to the initial cost. Would a portion of this added cost utilized for new mechanical methods in the placement of base achieve the results we are looking for at less cost? Recently Philadelphia contracted for base paving of standard 1:3.6 mix, including a special mechanically applied surface treatment, producing an indented face for an asphalt wearing surface. In addition to ridging or corrugating the surface of the concrete, the method employed apparently "squeezed out" the excess water in the carrying vehicle. A 3½-inch square by 7-inch prism of this concrete was sent to the laboratory and substantiated the claim of a strengthening increment, incidental to the process, by developing a unit compressive strength of 2430 pounds, 62 percent over the

usually accepted figure of 1500 pounds per square inch for this mix. We are not selling this idea; the thought merely occurs that this field of research is still open.

Have we secured the best results with the means at our command? Would the increased cost of additional depth of concrete or stronger mix or reinforcement be absorbed or approached by greater care exercised in preliminary preparation, more rigid adherence to specifications, the reduction to a minimum of the vagaries of human judgment, less speed and better quality in the making and placing of six-inch base? The same elements of uncertainty may and probably will exist no matter what new type of construction is advocated and used, whereas conscientious effort and a betterment in methods both in construction and maintenance may be the measure of the most efficient kind of production at less extra cost and without radical changes.

The problem deserves and will receive, no doubt, serious study. If and when changes in type of construction become a part of standard specifications, it would seem that the exercise of good judgment will be essential and necessary as special conditions arise, or when, in the opinion of the engineer, present and anticipated traffic demands are not a part of the consideration of initial costs.

On the other hand we face abnormal conditions in modern transportation, and no one can foresee where the limitations of weight, volume and speed will end. The idea of first cost must be left out of the picture, and we will perforce accept necessary changes in design and construction, building for the factor of resistance upon the same principles as in bridge work and as economically as we may. The end will justify the means.

Rights of States to Limit Truck Weights

The United States Supreme Court, in a decision of a case brought against the Oregon Highway Commission by certain trucking companies, attacking the validity of an order reducing load limits on the Columbia highway from 22,000 to 16,500 pounds, upheld the right of the state to place such a limit.

The court declared that the mere fact that a truck company cannot make a profit unless it can use a truck with a load weighing 22,000 pounds does not show that the regulation forbidding it is either discriminatory or unreasonable. "That it prevents competition with freight traffic on parallel steam railroads may possibly be a circumstance to be considered, though that is doubtful, but it is necessarily outweighed when it appears by decision of competent authority that such weight is injurious to the highway for the use of the general public and unduly increases the cost of maintenance and repair," the court said.

Authority to make limitations must rest with the state highway authorities, said the court, not only because of the general constitutional distinctions between the national and state powers, but also for the reason that the contract existing between the federal government and a state which has accepted federal highway aid, imposes upon the state the burden of maintenance after construction. Regulation as to the method of use of the road must remain with the state and "cannot be interfered with unless it is shown to be so arbitrary and unreasonable as to defeat the useful purposes for which Congress has made its large contributions to bettering the highway systems of the Union."

Classification of Subgrade Soils

A report has been made by Dr. Charles Terzaghi, research consultant to the Bureau of Public Roads, on the principles of soil classification from the point of view of the action of a given soil as a road subgrade. This report, published in the May issue of "Public Roads," discusses compressibility and elasticity of soils, grain sizes, permeability, and capillary pressure, and develops the following conclusions:

The data on which it is proposed that the final soil classifications be based, give information about the following properties of the subgrade:

1. The volume change produced by a change of the external pressure (load) which acts on the soil (compressibility and elasticity of the soil).

2. The speed with which the volume change follows a change of the pressure (coefficient of consolidation).

3. The permeability of the soil (coefficient of permeability, computed from the coefficient of consolidation or, for more permeable soils, directly obtained by means of a permeability test, performed under standard conditions).

4. Volume change due to drying and wetting, under standard conditions (obtained from the shrinkage limit and from pressure—voids-ratio diagrams).

5. Consistency of the soil in two extreme states.

The technic of the tests required for obtaining the aforementioned data will be described in another paper. All these data have simple and well-defined bearing on the behavior of the subgrade under load and under variable atmospheric conditions.

The investigations concerning the colloidal character of soil constituents, dye adsorption, base exchange, etc., fall in the same class as the recent investigations concerning the effect of the carbon content, and of various alloys on the strength of steel, or analyses of the physical and chemical action in cement during the process of setting, or similar intricate physicochemical problems relating to construction materials. There is no question of the value of the ultimate results of such investigations. Yet in the classification of construction materials for engineering purposes it is very doubtful whether anything more efficient than the present system, based upon the behavior of the material under stress, will ever be obtained.

If a road surface cracks because of subsurface conditions, or if a foundation settles, it is due exclusively to a strain in the subgrade, produced by a change of the intensity and distribution of the pressure which acts in the subgrade. Hence, there is no reason to base the final system of soil classification on anything except on the behavior of the soil under various conditions of stress and of confinement. Since the data required for classifying the soils are obtained from actual measurements, performed under standardized conditions, the principles of the system

will continue to be valid regardless of the ultimate outcome of physical and chemical investigation of soils.

Water Works Improvements Reduce Fire Rates

When the city of Dubuque, Ia., changed to the city manager form of government the new administration, realizing that the water works plant needed many improvements, asked the national Board of Fire Underwriters to make a survey of these works and of the fire department. Having made the survey, the National Board recommended many improvements and changes in both departments, at the same time agreeing to lower fire insurance rates from the very high class that Dubuque had been placed in if these were carried out.

The most important water works improvements carried out were a 7½-million gallon covered reservoir costing $36,500; fireproof pumping station, $34,704; fireproof booster station $10,215; electric driven equipment in both, $131,851; new mill, $17,-731; relining old reservoir $10,000; and erecting 600,000-gallon standpipe, $17,333. A total of $631,039.

The fire rates were thereafter lowered, effecting an annual saving of $50,000 in fire insurance rates paid by the citizens.

Only $375,000 in bonds were sold to cover the cost of the improvements, the remainder being paid out of the earnings of the department. Moreover, $2,700 a month is paid into a sinking fund, which will pay all interest and redeem the bonds as they mature.

Concrete Cradles for Large Pipe Conduits

Tests made at Iowa Engineering Experiment Station show that supporting strength of pipe may be increased fifty to one hundred per cent by use of properly designed cradles

A series of tests on the additional supporting strength of pipe furnished by bedding it in cradles was completed last year by the Iowa Engineering Experiment Station in cooperation with the Bureau of Public Roads, and the results reported in Bulletin 80 of Iowa State College. The major problem considered was "the collection of such information as will enable the designer to choose the type of cradle best suited for a particular installation, and which will permit a more rational choice between cradled pipe construction and other types of structures. The investigations include also some studies of the value of reinforcing steel in difficult types of cradles."

Tests were made of 24-inch pipe in four types of cradle; of 36-inch in six types; and of 48, 60 and 84-inch, each in two types. For the cradle, gravel concrete proportioned 1:2:2½ and 1:2:3½ was used, with a flat lower sand bearing, 28 days old when the test was made. For comparison, similar pipe were subjected to standard strength tests with three-edge bearings.

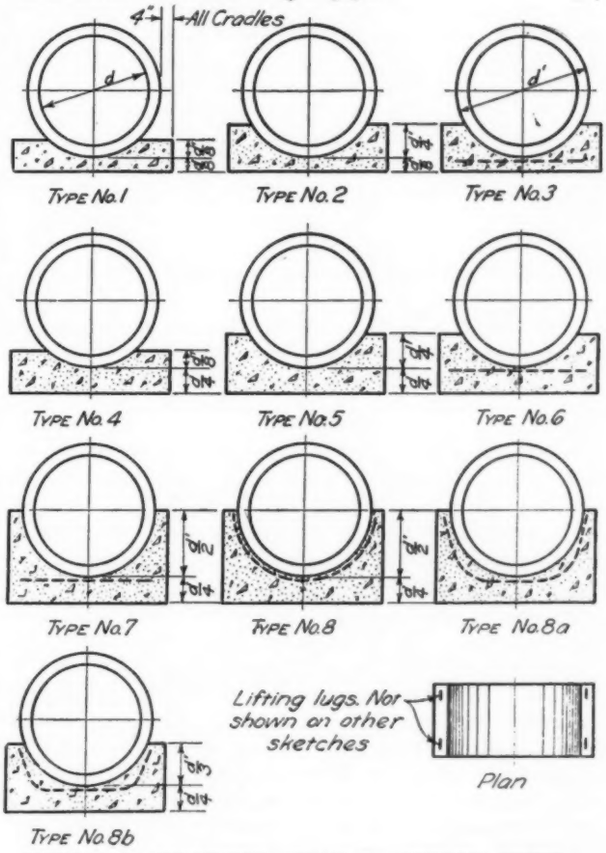
The pipe used were similar, except for length, to the regular commercial product . The two smallest sizes used two lines of mesh reinforcing. In the three largest sizes, two lines of bar reinforcing were used, in amounts about the average required by railroad companies.

All cradles used were eight inches wider than the outside diameter d′ of the pipe . Some had a minimum thickness under the pipe of one-eighth the inside diameter d, others of one-fourth d. The sides were brought up an additional height of ⅛d′ in some and ¼d′ in others, some of the latter having horizontal reinforcement under the pipe. Also some cradles were made ¼d thick and ½d′ high with either flat reinforcement or curved parallel to the pipe.

GENERAL CONCLUSIONS

The more important of the conclusions from these studies may be summarized as follows:

"(1) The supporting strength of pipe before cracking may be increased 50 to 100 percent by the use of properly designed cradles. This percentage of increase with a particular cradle will vary with the quality of the pipe and is higher for the weaker and lower for the stronger pipe.



TYPES OF CONCRETE CRADLES TESTED WITH 24-INCH TO 84-INCH PIPE

"(2) The use of a cradle which has a thickness under the pipe of one-fourth the nominal diameter of the pipe (¼d) and which extends up the sides to a height of one-fourth the outside diameter of the pipe (¼d′) should increase the supporting strength about 75 percent.

"(3) Decreasing the proportional thickness of the cradle under the pipe and its height at the sides, each reduces the effectiveness of the cradle.

"(4) It is doubtful if it will be economically advisable to use reinforcing in a cradle with a thickness less than ¼d under the pipe and a height at the sides of less than ½d′ for small pipe or 1/3d′ for large pipe. Reinforcing appears to be of value only in that portion of the cradle under the pipe. None of the cradles tested developed a visible fracture or crack except under the pipe. Properly designed and constructed reinforced cradles of these dimensions should increase the cracking strength of the pipe 75 to 100 percent.

"(5)) Because of the lack of opportunity to develop side support as the pipe deformed after cracking, the ultimate loads sustained by cradled pipe in these tests can be considered as measures of only the minimum ultimates which similarly cradled pipe would develop in actual installations.

"(6) If the effectiveness of cradles for reinforced concrete pipe is to be based upon the supporting strength of the pipe before developing a crack of a specified surface width (as 0.01 inches), consideration should be given to the higher supporting strength of the pipe itself at this cracking load, and to the side support that may be developed through the deformation of the pipe and the cradle. This side support might be material in the case of pipe in trenches in firm soils.

"(7) Experience in making these tests confirms the desirability of the methods for making strength tests of reinforced concrete pipe as prescribed in the Tentative Standard Specifications for Reinforced Concrete Culvert Pipe of the Joint Concrete Culvert Pipe Committee (1926)."

Concerning reinforcement of cradles, the investigators say:

"In these tests there seems to be no particular value, so far as supporting strength is concerned, of carrying the reinforcing up into the sides of the cradle. No cradle developed a visible crack or fracture except under the pipe.

"Although the results with the cradles reinforced with mesh showed the reinforcing to be of no value (the cradles so reinforced gave slightly lower strengths than similar cradles unreinforced), the results with cradles reinforced with ⅛x1-inch bars leads to the belief that reinforcing is of value, particularly in cradles with a height of more than ¼d′ at the sides. It is probable, also, that the value of reinforcing will be much more apparent when the cracking strength is determined by the load producing a crack 0.005 or 0.01 inch wide. The reinforcing will be of more value in cradles for conduits in embankments than for those in trenches in firm soils. In the latter case, the soil at the sides will develop sufficient side support to increase the supporting strength of the pipe somewhat.

"In most cases the cost of cradling, and the increased supporting strength so obtained will limit the cradle to a type similar to ¼d—¼d′ unreinforced cradle, or the ¼d—½d′ reinforced cradle used in these investigations. For large pipe it may prove desirable to reduce the height at the sides to 1/3d′ or 2/5d′.

"For pipe to be laid in trenches in firm soil it is doubtful if it will be economical to reinforce the cradle, unless it be for large pipe in deep trenches in which case the ¼d—½d′ cradle probably will be required. For pipe to be laid in embankments, or in yielding soils, cradles extending higher than ¼d′ at the sides should be reinforced, and in many instances it will be advisable to reinforce the ¼d—¼d′ cradles, because the side support developed will be small."

ECONOMICS OF CRADLES

"Concrete cradles normally will be used only when the required supporting strength can be secured at a lower cost than by other means such as stronger pipe or monolithic construction. The cost will vary so widely that it is useless to do more than indicate the increase in cost when one type of cradle is used.

"If concrete for cradles in place costs $15 a cubic yard, the ¼d—¼d′ cradle (type 5) for 36-inch pipe will cost about $2.85 per linear foot of pipe. On culvert work, where concrete headwalls are to be provided, the unit cost of the concrete in the cradle will be reduced to about $12, making the cost of the cradle about $2.30 per linear foot. The costs of a ¼d—½d′ (type 8b) reinforced cradle in this example would be $3.50 and $2.80 per linear foot.

"Where conditions require supporting strengths 50 percent or more above those of the normal commercial conduit it is possible that cradling or monolithic structures are the only alternatives.

"This discussion takes no account of those cases where it is desirable to place the pipe upon a concrete base for reasons other than to increase the supporting strength of the pipe. In such cases the cost of securing the increased supporting strength will be lessened."

Chlorine Gas for Sewage Treatment in Germany

An article by Dr. H. Bach, chief chemist of the Emscher Corporation of Essen, Germany, in the "Technisches Gemeindeblatt" is abstracted as follows by J. K. Hoskins in the Engineering Abstracts of the Bureau of Public Health Service.

Because of the impoverished condition of the country, Germany is forced to forego the construction of complete sewage treatment works; chlorine gas disinfectant appears to the author to supply the needs of health protection.

"Materials in gaseous form are destroyed more rapidly by chlorine than are liquids, and these, in turn, more rapidly than solids." In addition to oxidation of organic matter, reaction products are probably generated by chlorine which are effective as plant and animal poisons even after the exhaustion of the free chlorine content.

For many reasons (given by the author) chlorine gas is to be preferred to hypochlorites for sewage

disinfection, and is accordingly coming into more general use. The development of the indirect method of chlorine application (that is, the formation first of chlorine water by solution of measured amounts of gas to water, and then addition of this solution to the water to be treated) both in America and Germany, is outlined. This method is now used exclusively for treatment of municipal sewage by chlorine.

Extensive experiments of the Emscher Corporation have indicated that to produce a disinfectation resulting in a 99 per cent, reduction of the bacteria (growing on gelatin plates) is concentrated fresh municipal sewage which has not as yet decayed to any appreciable extent, the following additions of chlorine proved necessary: (a) For crude, unclarified sewage containing fecal matter, 25 to 30 g. per cu. meter; (b) for sewage briefly (½ hour) clarified by sedimentation, 15 to 20 g. per cu. meter; (c) for well clarified sewage, 10 to 15 g. per cu. meter.

If the sewage is stale, larger amounts of chlorine are required. In all cases a period of reaction is essential, generally from 30 to 15 minutes, depending on concentration, temperature, etc. Offensive odors of stale sewage, usually due to formation of sulphur compounds, may also be eliminated by chlorine treatment.

Chlorination of sewage as a substitute for biological treatment is discussed at length. Delay of decomposition may be obtained by chlorine frequently for a period long enough for the treated sewage to reach sufficiently large bodies of diluting water without creation of nuisance. However, "chlorinated sewage can not be considered the equal of effectually biologically purified effluents."

Digestion of Activated Sludge[1]

Results of experiments on effects of seeding activated sludge with ripe Imhoff sludge, mixing ripe sludge and fresh solids with it in proportions to secure the most rapid digestion, and effect of reaction control on digestion

By W. Rudolfs[2] and P. J. A. Zeller[3]

The present interest in the possibilities of economic digestion of activated sludge warrants a brief discussion of some results recently obtained in our laboratory. During the past year we have conducted a series of experiments for the purpose of obtaining information regarding the effect of several factors on the digestion of activated sludge.

Some of the topics studied, part of which are discussed in this paper, comprised: (1) The effect of the seeding of activated sludge with ripe Imhoff sludge on the subsequent digestion of activated material; (2) Mixing ripe sludge, fresh solids, and activated sludge in different proportions to find the best mixture for most rapid digestion; and (3) Effect of reaction control of activated sludge and different mixtures on the digestion of the materials. Further, the effect of the different factors upon the amounts of gas produced and its composition was studied in considerable detail. All the accumulated data will eventually be published in our annual report, which however will probably not be published for another year or more.

Published data regarding the digestion of activated sludge are very scarce. None seems to be available dealing with proper reaction control and the amount and composition of the gas produced.

PROCEDURE

As stated above, only a small part of the experiments will be discussed in this paper, but some of the statements and conclusions are based upon all the experiments.

It has been pointed out by us before that carefully controlled experiments will give accurate and comparable results only when the material used for comparison comes from the same source and is collected at the same time. Results obtained in this way are comparable for different mixtures provided the analyses of the mixture are reduced to a common basis. We have particularly in mind that the amounts of *volatile matter* present must be compared rather than the amounts of solids, if mixtures consisting of different components are used. For this reason the ratios of ripe sludge, fresh solids and activated sludge employed were calculated on the basis of dry volatile matter. The mixtures reported upon here consisted of:

Nos.	Ripe sludge	Fresh solids	Activated sludge
32,46	1	1	0
36,50	1	0.5	0.5
39,53	1	0	1
44,58	0	0	1

The experiments were conducted in duplicate; in one series the bottles were opened at intervals and the contents analyzed, whereas the bottles of the other series were opened for the first time after 103 days. For the correction of the reaction of the closed series, other parallel bottles were incubated, the reaction determined and, when necessary, lime was added to the closed series through a special check valve, so that no air could enter. After the initial correction, additions of small quantities of lime were necessary only once or twice. All the mixtures under discussion were incubated at a temperature of about 70°F.

ANALYSES

Gas production of all materials was measured daily and analyzed at intervals. Analyses of solids and ash and p H determinations were made regularly and bacterial and protozoan numbers recorded. Results were expressed in grams volatile matter. Since all results will be published later, the method of

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collecting gas, together with a description and drawing of the apparatus used, a discussion of heat values of the gas in B.t.u. values, details of bacterial and animal counts, will then be presented.

RESULTS

Reaction—The reaction of the mixtures under discussion did not change greatly. The pH values of the unlimed materials were at the start all around the neutral point. The activated sludge alone was lowest, namely pH 6.8. All these mixtures soon reached pH values of 7.3-7.5. Under certain conditions the mixtures reached pH values of 7.8-8.0.

Gas Production—Gas production from activated sludge alone, although rapid during the first few days, lagged behind the activated sludge which was seeded with ripe sludge. The gas production of the ripe sludge + fresh solids + activated sludge mixture was slightly behind the ripe sludge + activated sludge mixture. The ripe sludge + fresh solids mixture produced less total gas at the end of the experiment than the activated sludge which was seeded. The effect of lime on gas production was persistent during the course of digestion.

For comparison, the amounts of gas produced after 40 days is given in table 1. All figures are calculated on the basis of cubic centimeters gas per gram organic matter originally present. For convenience of the engineer these figures have been converted into cubic feet gas per 100 pounds dry organic matter present when the experiments were begun.

Table 1—Total Gas Produced After 40 Days

No.	Mixture	cc. per gram vol. matter	cu. ft. per lb. vol. matter
	Unlimed		
32	R. S. + F. S.	411	6.56
36	R. S. + F. S. + A. S.	375	5.99
39	R. S. + A. S.	283	4.52
44	A. S.	387	6.18
	Limed		
46	R. S. + F. S.	410	6.55
50	R. S. + F. S. + A. S.	429	6.85
53	R. S. + A. S.	678	10.82
58	A. S.	392	6.25

In spite of the fact that the sludge used for seeding was considered to be "ripe" when drawn and thereafter was kept in our laboratory for two months so that gas production has practically stopped, we can not attribute all the gas given off by the mixtures as coming from the organic matter in the fresh solids or activated sludge alone. Our experiments show that whenever fresh solids are added to ripe sludge, the ripe sludge undergoes further decomposition. However, when frequent sludge drawing is practiced, the relation between ripe sludge and fresh material kept constant and the sludge heated to 70°F, gas production of the different mixtures will have the same relation as indicated in Table 1. If we assume that the gases produced come from the undecomposed materials only, the ratios would be as follows: (ripe sludge + fresh solids mixture taken as 100)

Mixture	Unlimed	Limed
R. S. + F. S.	100	100
R. S. + F. S. + A. S.	92	104
R. S. + A. S.	69	165
A. S.	47	48

The figures show two outstanding results:

1. The amounts of gas produced from activated sludge are less than from fresh solids, whether properly seeded or not.

2. Additions of lime to seeded activated sludge increases the amounts of gas considerably.

Time required for digestion—If gas production is taken as an index of digestion (the rate of gas production designating the progress of digestion or the time required for satisfactory digestion) we find that *unlimed,* properly seeded, activated sludge digested most rapidly; next, the mixture of ripe sludge + fresh solids + activated sludge; followed by the ripe sludge + fresh solids mixture; and finally activated sludge alone. The *limed* mixtures digested in a different order. First came the mixture of ripe sludge + fresh solids; followed by the ripe sludge + fresh solids + activated sludge mixture; then the seeded activated sludge; and finally the activated sludge alone. Expressed in the number of days required for satisfactory digestion (time required until the peak of gas production had passed and material was ready for drawing on to drying beds) we find the differences quite considerable (Table 2).

Table 2—Lime Required for Satisfactory Digestion at 70°F

Mixture			Unlimed	Limed
Ripe-	Fresh-	Activated	(ratios)	
1	1	0	32-35	30-35
1	0.5	0.5	28-32	40-45
1	0	1	28-30	50-55
0	0	1	56-60	50-55

It is obvious that as soon as activated sludge is added to ripe sludge and the mixture adjusted to a reaction of pH 7.3 with lime, gas production is increased, but at the same time digestion continues longer. In addition (we have stated this before), lime retards total gas production at the beginning, but increases total gas production later. The reasons for this behavior are published elsewhere. A more lengthy theoretical discussion of the fact and reasons why activated sludge alone and mixed with seed material depresses total gas production is out of place here but will be found in the publication in press at this writing. It should be stated here, however, that the amounts of gas produced for a given quantity of volatile matter decomposed are in every instance greatest from the limed mixtures.

ODORS

The question of odors emanating from different mixtures is an important one. Our weekly score cards on the intensity and duration of odors show that for unlimed mixtures the most odors were produced by the ripe sludge + fresh solids mixture, followed in intensity by the ripe sludge + fresh solids + activated sludge mixture, and the least from the seeded activated sludge. The odors coming from limed ripe sludge + activated sludge mixtures were less than from the ripe sludge + fresh solids mixture. During only a brief period was a strong putrefactive odor noticeable from the seeded activated sludge treated with lime. It is now well known that properly seeded and properly treated, well built, separate sludge digestion tanks do not produce obnoxious odors, especially if the gases are collected. The odors from seeded acti-

vated sludge stored in insulated tanks and kept under practical (scientific) control could scarcely be detected.

HEAT VALUE OF GASES

An accurate account of the composition of the gases will be given later. The heat values (B.t.u.'s) of the combustible gases produced were approximately the same in all instances per given unit (volume) of gas. The percentage methane in the course of digestion varied from 64.2 to 79.3%.

AMOUNTS OF LIME USED

The amounts of lime added to the different mixtures, necessary to maintain pH values of 7.3 or higher, were comparatively small. Expressed in pounds of dry hydrated lime per 100 pounds of dry organic matter, the following amounts were added:

Mixtures Ripe-Fresh-Activated			Pounds
1	1	0	8.4
1	0.5	0.5	4.9
1	0	1	5.2
0	0	1	6.1

If no alkaline products were produced by the digesting material, and assuming that 4,000 pounds of dry solids were received with an ash content of 25%, the amount of lime required per million gallons of sewage daily would be 75 pounds for the ripe sludge + fresh solids mixture; but when the proper amounts of fresh solids are added daily, the alkaline substances produced are sufficient to counterbalance the production of acid substances. If daily quantities of fresh solids were added which had undergone partial decomposition, so that we could say the "fresh" solids are added in all stages of digestion, amounts to 20 to 25 pounds of lime per million gallons of domestic sewage would be required. It is, therefore, far better to add solids as fresh as possible every day in small quantities, (this includes fresh activated sludge), when only occasional lime additions are required provided the sludge is kept at a temperature of 70°F or above. In case maximum gas production is required, the amounts of lime necessary would be from 10 to 12 pounds per million gallons of sewage, containing 3,000 pounds of dry volatile matter.

CONCLUSIONS

1. Activated sludge digests most rapidly when seeded with proper amounts of ripe sludge.
2. Properly seeded activated sludge digests more rapidly and with less odors than properly seeded fresh solids.
3. If gassification is desired, properly seeded activated sludge should be treated with hydrated lime to a pH value of 7.5-7.6 (when necessary.)

Bridge Maintenance in Michigan

To guard against defects in bridges, such as inadequate railings, dangerous floors and improper approaches, the Michigan State Highway Department inspects thoroughly at least twice each year every state trunk line and federal aid bridge.

Bridge maintenance crews are kept in the field at all times to care for both routine maintenance and emergency jobs. Each crew consists of a foreman and from 3 to 6 men, and is equipped with a truck and the necessary tools to do ordinary repair work. Special truck units are provided for the transportation of paint spray equipment, cement guns, air compressors and other heavy equipment. During the past two years, the number of crews has varied from 2 to 7, with an average of 5 in the field at all times. The number of crews and the men employed are reduced during the winter, the foreman and experienced men being retained as a nucleus for the following year. The work of the crews is supervised by the Bridge Maintenance Superintendent.

There are now 601 bridges with clear spans of 30 feet or more which are maintaind by the State Highway Department. Of this number 305 are of concrete and require little or no maintenance; 281 are of steel, and must be painted at regular intervals. The number of timber floors has been reduced to 111, but as such floors require renewal at intervals of 3 to 5 years, this item of work is still important.

The painting of steel structures is one of the most important items of maintenance work. Under ordinary conditions, one coat of paint every 5 years is required, but the Department has not been able to maintain this schedule. Moreover, nearly 100 of the 281 steel bridges will have to be replaced within a few years due to light construction, narrow roadway, or other reasons, and no attempt has been made to keep these bridges thoroughly painted.

Repair and replacement of floor surface is another important item of the work. For steel structures which will not carry a concrete floor, a double timber floor of 2-inch plank laid longitudinally on 3-inch plank placed transversely is standard. The longitudinal plank may be expected to have a life of 4 years, while the transverse plank if given a brush coat of creosote, will last about 8 years.

Aside from painting bridges and repairing floors, bridge maintenance work consists of repair of substructures, superstructures, railings and back walls, placing sheeting and riprap, and putting seal coats on wood-block, bituminous and concrete floors. The maintenance crews also are often utilized to perform construction work, such as field painting of new structures, constructing sidewalks on existing bridges construction of approach spans, building of temporary bridges, and completion of work taken over from contractors.

Remedying Water Shortage at Leominster

Leominster, Mass., was settled in 1701, incorporated in 1740, and its water works established in 1873. The population in 1925 was 22,120 and water consumption about 2.6 m.g.d. The supply is derived from streams, the low service from a total water shed area of 1.91 sq. mi. and the high service from 1.45 sq. mi. In 1926 there were 4026 service connections, of which 3561 were metered.

In December 1924 the city was threatened with a water shortage, the reservoirs, especially that of the high service, being nearly empty. Permission was obtained from the State Board of Health to use temporarily water from Monoosnock Brook, which has a drainage area above the city of 7 sq. mi. and is used for power by a number of manufacturing concerns in the city, which jointly maintain a reservoir for equalizing the flow. One of the mills loaned the city an Allis-Chalmers 6-inch cen-

trifugal pump operated by a 3-phase 150 h.p. 2200 volt motor, which was installed in an unused mill located on a pond a little lower than the reservoir. This was used for 36 days during January and February, supplying 862,000 g.p.d. There was some sewage entering this supply, and two Wallace & Tiernan manually controlled chlorinators were installed at a total cost of $1,336. Said W. G. Classon, superintendent of the water works, in his annual report: "Where dependence is placed upon a single chlorinator, any slight accident to it involves the use of untreated water until the chlorinator can be repaired. In this particular case the duplicate installation proved absolutely essential, since the vibration due to the installation of the pump without a masonry foundation and the nearness of the chlorinator to the pumps would have resulted in comparatively frequent interruptions of service but for the duplicate. With it, continuous chlorination was obtained."

The cost of the entire installation—moving and erecting pump and substituting a new impeller to furnish higher pressure, purchasing and installing chlorinators, engineering, etc., was $3,675; and the operating cost, including $697 for current, was $2,667. This gave a cost of $204.59 per million gallons of this emergency supply used.

In 1926 the city obtained permission to take over this source of supply permanently. The property of the largest user, an electric light company, was purchased at "a very reasonable price" and all other mill owners were settled with for the diversion of the water and for their rights in the reservoir.

This experience called attention to the possibility of leakage in the distribution system and a few months later the city contracted with the Pitometer company to locate leaks, determine the capacity of the mains, check manufacturing consumption and test in place all meters of 4-inch size and larger.

This survey disclosed several leaks in the high service, totaling about one-fourth of the daily consumption from this system. The largest was from a 12-inch pipe in the heart of the city, where about half of a lead joint had blown out and 187,000 g.p.d. was escaping. Under-registration of factory meters was found totaling 49,000 g.p.d. The total was 332,000 g.p.d. or more than 12 per cent of the total consumption.

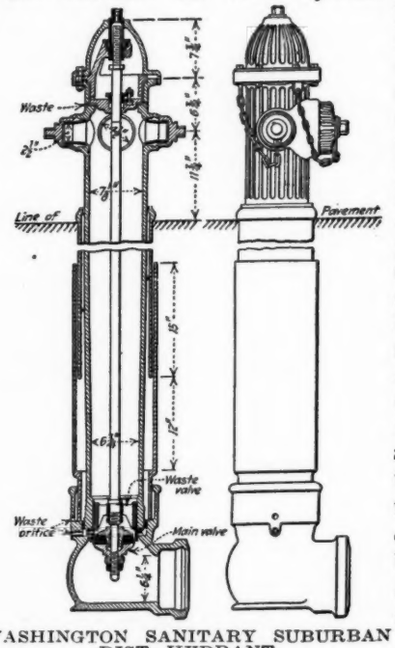
Practical Hints On Maintenance of Water Systems*

Designing, repairing and painting fire hydrants, inspections and record of condition, maintenance of valves and house connections. Minimizing water hammer. Priming centrifugal pumps

In the following article several practical ideas which have been used with success are described. Not all of them are original but many have been thought out by members of our own force engaged on the work.

FIRE HYDRANTS

The problem of properly maintaining fire hydrants in rapidly growing suburban areas is specially troublesome. In the Washington Suburban Sanitary District many hydrants were set at the commencement of our work, before streets were graded and in some cases before the grades were even established. At present, although the grading has not always been done, definite street grades are established. We are using the Mathews hydrant, with several changes designed by our chief engineer, Robert B. Morse, which is especially adapted to this class of work. The hydrant barrel is screwed into the bottom elbow base, and protected by a frost casing up to the ground level. It is possible to remove the complete barrel of the hydrant for repairs, by unscrewing it from the base and removing it from within the casing, without digging up the ground around it. The barrel is made in different lengths so that a shorter or longer one can be quickly substituted when changes in grade are made. The manufacturer's standard frost casing is made in one piece, however, which does not allow of adjustment, and therefore the whole hydrant except the base has to be removed when the street grade is changed to any considerable extent. Our hydrant, on the contrary, has a frost case in two pieces, one section working inside the other like a valve box, making it possible to shorten or lengthen the frost case within a total range of two feet. Thus the top section of the casing can be raised or lowered so that the top will come just above the new ground surface, and a new hydrant barrel of the proper length inserted. Adjustment of the frost casing requires only a small amount of excavation. Often to set a fire hydrant to proper grade would



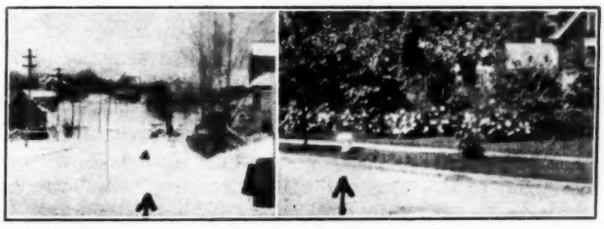
WASHINGTON SANITARY SUBURBAN DIST. HYDRANT

*Extracts from paper by Carl A. Hechmer, department engineer, Maintenance and Operation Department, Washington Suburban Sanitary District, Hyattsville, Maryland, before the First Annual Conference of Maryland Water and Sewage Plant Operators.

mean installing it in such manner as to be nearly buried, and therefore not available for service, or else it would stand so high in the air that it would be unsightly and likely to be frozen. We set our hydrants as near to proper grade as possible but also make sure they can be operated with ease. When the street grade is changed we adjust the frost case and install a new barrel, as described above. We have saved much money and maintained better appearances by using this type of hydrant. The details of the Washington Suburban Sanitary District type hydrant are shown in Figure 1.

Hydrants should be painted occasionally, to protect them and for the sake of appearance. we find that once a year is not too often to do so. The color scheme is a light gray barrel with a dark green top.

HYDRANT WITH GRAY BARREL AND DARK GREEN TOP



VISIBILITY OF HYDRANT IN WINTER AND SUMMER

The light gray barrel shows up very plainly at night. In the day time there is also a decided contrast against the green hedges and grass parkings which predominate in our area. The dark green top makes it easy to spot the hydrant when snow is on the ground and yet the green color blends with the landscape and is pleasing to the eye.

Hydrants are inspected three times each year, in early fall, winter and spring. Flushing is done in the fall and spring but not in mid-winter because of the formation of ice in the streets. A record of the inspection, nature and cost of each repair is kept on a card system, but for quick reference we have originated an idea which has been highly commended by the Fire Underwriters' engineers. We use a map, made on a 600 foot scale, mounted on wall board for this system. A push pin shows the location of each fire hydrant. The color of this pin denotes the condition of the hydrant, blue being used for a hydrant in good condition, black for a hydrant which is in need of minor repairs, but still operative in case of fire, and red for a hydrant which is entirely out of service. We, of course, make every effort to keep all blue pins on the map, but a red pin is rarely left on the map over night and then the local fire department is notified. When a hydrant is reported out of service a glance at the map shows us whether all the hydrants immediately around it are in good condition. As many different makes of hydrants were used on the several systems acquired by the Sanitary District, it is an advantage to know the make of hydrant before sending out a repair gang so the proper parts may be carried along. By using small round colored discs under the push pin we can determine at a glance the make of the hydrant, a different color of disc being used for each make of hydrant. Small celluloid flags are used to show the date of the last inspection in the various areas. The dates are written on the flags in ink and can be easily washed off and corrected with each subsequent inspection.

Two especially simple operations are worth mentioning with regard to fire hydrant operation. Frequently a hydrant will open with difficulty during freezing weather, due to freezing of moisture in the stuffing box. Since all fire hydrants have a stuffing box the trouble can occur in any make. This usually can be overcome by tapping the operating nut with the hydrant wrench. The jar will free the stem from the packing and the hydrant will open with its usual ease.

Especial care must be taken to see that the drain valve is functioning in freezing weather so the barrel will be emptied automatically each time the hydrant is used. Occasionally a stone or some clay will get into the drain hole and prevent drainage. We clear this kind of trouble by opening the main valve of the hydrant one full turn, leaving the nozzle caps on tight. As it requires about three full turns on the main valve to completely close the drain valves on most makes of fire hydrants, the latter is still partly open on one turn. The full pressure of the water in the hydrant generally will push out any obstruction in the drain hole and the jet effect of the water through the hole will cut away the stone or earth which has packed around the outside. This simple remedy has eliminated the necessity of digging up the hydrant in most cases to correct drainage troubles.

VALVES

Valves must be operated regularly to keep them in proper working condition. The Fire Underwriters require annual inspection, but in rural sections with a large percentage of unpaved streets, more frequent inspections are necessary if the valve boxes are to be kept to proper grade, ready for emergency operation. Frequently, when a shut down is attempted, one or two valves will be found leaking through, although the stems have been turned down tightly. Generally such valves can be made tight by operating them up and down, bringing the gate down into the groove each time and then opening the valve about one quarter way. The trouble is usually caused by the accumulation of sediment under the seat. Each time the gate is pushed down into the groove a small portion of this sediment is pushed out the sides. The high velocity of the water through the partly opened valve removes what is pushed out and the operation is repeated until the groove is sufficiently cleaned to allow the gate to seat properly, thereby cutting off the flow of water. Of course,

if the groove is filled with large stone or jointing material, the valve must be dug up and taken apart for repairs. I remember operating one 16-inch valve thirty times and getting a perfectly tight shut down. The valve had not been operated for a long time, having been declared worn out since it always allowed a large volume of water to pass with the gate turned down hard with levers on the key.

With constantly changing street grades, valve boxes must be lowered and raised frequently. We use the sliding type of adjustable valve box and formerly experienced trouble in keeping the boxes to grade after changes in unimproved streets carrying heavy traffic had been made. By using two pieces of plank, twelve inches long and six inches wide, cut to fit around the barrel of the lower section of the box in the shape of a clamp, more bearing surface is given the upper section and we now have little trouble with boxes being pushed down below grade.

We have adopted the use of posts to indicate the location of main line control valves along roads in unedveloped sections where there are no houses or poles to measure from. A three-inch pipe, five feet long, capped on the upper end, is set in a small concrete base with two feet bury. The body of the post is painted green and the cap light gray. An arrow and the distance to the valve is painted on the side of the post facing the valve. These valve posts are an advantage when the valve boxes are covered with mud or snow.

HOUSE CONNECTIONS

We have been very successful in relieving complaints of low pressure or insufficient supply in house connections, generally due to partly clogged piping, with the use of a small portable hand-pressure pump. A connection is made by means of a hose to the service pipe near the cut-off valve in the cellar and water is then pumped into the service pipe. Usually only a few quarts of water are necessary to pump the pressure up to about three times the pressure in the street main before the stoppage or accumulation of sediment will give way. It is usually not safe to pump higher, and if relief is not secured the service pipe must be dug up and replaced in the stopped section. Unless the stoppage is due to hardened encrustation, the force pump usually is effective. We always cut off the house plumbing so as not to subject any of the interior plumbing to the high pressure.

There are several instruments on the market which aid maintainance work on distribution systems. The electric pipe locator is one of them and if used carefully is a very valuable instrument. We have found it capable of doing all the things claimed for it by the manufacturers and we have saved its cost many times in locating old pipes. We recently took over the control of a small water system containing several miles of pipe lines and about 50 service connections. No drawings or records were available and we used the pipe locator to map the system. Pits dug on the main lines to install control valves and on all service pipes to install meter housings revealed, without exception, that the locator had indicated the correct location. After a little practice with the locator anyone can use it and depend on the results.

We have also saved hundreds of dollars using the electric leak locator in finding leaks on pipe lines, especially under improved streets. The first time we used the instrument we located a bad leak under a concrete street, the instrument having indicated the leak within 18 inches of the broken pipe, although water was coming out from both sides of the pavement for a distance of 25 feet and the largest volume of water was coming out at about 20 feet from the point at which the pipe was actually leaking.

The aquaphone is another instrument which we have found very useful. It sells for only a few dollars and resembles a telephone receiver. It is used to test house plumbing for leaks and to detect valves on distribution systems which fail to shut off the water tightly.

A dip needle is almost an indispensable instrument for locating valve and curb cock boxes which have become covered with earth or paving material. It depends on the principle of magnetism, the iron box attracting the manetized needle causing it to dip when it is passed over the box.

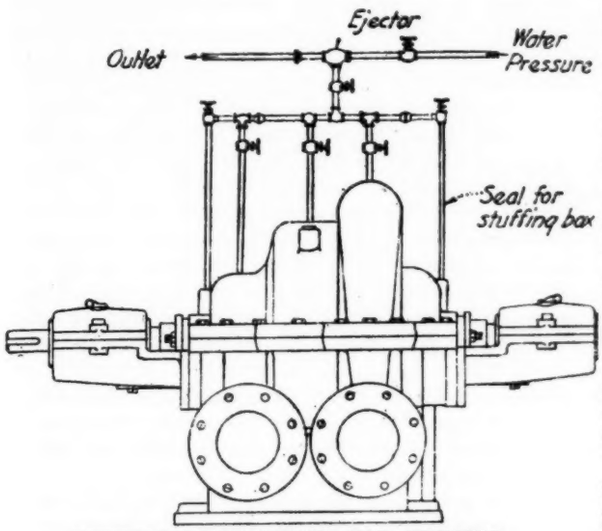
WATER HAMMER

In order to minimize the water hammer on our force mains we always close the discharge valves on centrifugal pumps slowly before shutting off the pump. However, when the pump is shut down suddenly due to accident, either the electric current failing or the power unit breaking down and the operator not having time to close the discharge valve, water hammer occurs and may cause serious damage. If the check valve holds, the main gets the full shock of the suddenly increased pressure, which on very long lines may build up to many times the normal pressure, and results in blown joints or cracked pipe. We are using pressure relief valves at our Burnt Mills Pumping Station which has a long force main leading from it. These valves are installed in manholes and set to open at fifteen pounds above maximum operating pressure. When water hammer builds the pressure up they open and prevent the pressure from going high enough to cause damage. We use the spring type of relief valve and find it very satisfactory. With any emergency appliances care must be taken to keep them in operating condition. We operate these relief valves once each week to prevent them from becoming stuck.

PRIMING CENTRIFUGAL PUMPS

We use a water ejector for priming centrifugal pumps where sufficient water pressure is available. The suction side of the ejector is connected by a series of pipes to the various stages at the top of the pump. The details of the connections are shown in Figure IV. With a known lift and water pressure available, it is possible to select an ejector which will prime the pump in any given number of minutes. We generally figure on a three minute priming period. The use of an ejector eliminates the necessity for a foot valve and the cost is very much less. There is also no maintenance cost of renewal of seats and valves. The greatest advantage, however, is the protection given the pump itself from back pressure or water hammer. If the pump is shut down suddenly due to accident, with the discharge valve open,

and the check valve does not hold, the water hammer on the pump line comes back through the pump, and if the water is held by a foot valve the pump casing will in all probability be damaged seriously. If there is no foot valve, the water hammer is relieved by the water passing directly through the pump back into the suction reservoir or well. Also we have experienced difficulty with check valves, as some of



EJECTOR CONNECTIONS FOR PRIMING CENTRIFUGAL PUMPS

them cannot be relied upon to hold tightly and to close quickly after they have been in service a comparatively short time.

Lead, Wrought Iron and Copper Goose-Necks*

By Emil L. Nuebling†

Water service pipes and connections at Reading, Pa., were and still are installed by and at the expense of the property owners. The work is generally performed by a plumber but no rule or regulation prohibits any other competent person from installing service lines.

The corporation cocks always have been installed by the operators of the water works. The original cocks had a tapered tail piece which was driven into a drilled and taper-reamed hole located at the top of the water main, and a pliable connection with the service pipe was made with a lead goose-neck. This method continued in use after the introduction of the first modern tapping machine, which permitted the making of ½ to 1-inch diameter taps. When it was observed that some service installations were being made with light-weight pipe, the water works officials had rules adopted specifying the minimum permissible weights of lead pipe that should be used, then listed as Class A.A. No serious trouble was experienced thereafter with service pipe connections until after the introduction of a larger tapping machine, which permitted the making of taps up to 2-inches in diameter.

Since no additional rule was made as to the weight requirements of the larger sizes of lead pipes and connections, the same class as specified for the smaller sizes was used in installing the larger sizes. Sometime after the installation of a number of the larger sizes of service connections, a good percentage of them split open; especially those of the largest size. The writer, who was then in charge of the water works, was surprised at the results of calculations made of the strengths of the various sizes of lead pipes, that the so-called classes, like Strong, Extra Strong, and Extra Extra Strong, did not carry the same degree of strength throughout the different sizes of pipes, but that, under any class, the strength of the smaller diameters of pipes was far in excess of requirements and that of the larger sizes was considerably below the pressures to which they were subjected. This is clearly shown in the accompanying table, which shows, for example, that a ½-inch Extra Strong lead pipe will safely withstand a working pressure of 220 pounds per square inch, while a 2-inch Extra Strong lead pipe will only take care of 69 pounds per square inch.

The regulations pertaining to service pipes were then changed to permit lead pipes of the following minimum weights: ½ inch—2 pounds; ¾ inch—3½ pounds; 1 inch—6 pounds; and to prohibit the use of lead in service pipes or connections in sizes of 1¼ inches in diameter and larger. For these sizes a flexible joint (permitting some settlement of main line, service line or both without pulling out or breaking off at the joints), was then required. The rule as adopted is: "Where 1¼, 1½ and 2-inch corporation cocks are used, the service pipe shall be connected without the use of lead pipe by means of straight, long-turn elbows, nipples and Kewanee or all brass unions. All fittings other than unions

Relative Strengths of Lead and Copper Service Pipes.

The pipes will withstand, in addition to the safe internal pressures listed, a 50 per cent increase, allowed to take care of water ram. The ultimate cohesion of lead is taken at 2,000 and that of copper at 30,000 pounds per square inch, each with a factor of safety of 5.

Dimensions in inches; weights in pounds.

LEAD PIPE
Extra Strong, A.A.

Nominal inside diameter..	½	¾	1	1¼	1½	2
Actual outside diameter.	0.96	1.21	1.48	1.76	2.07	2.51
*Calculated inside diameter	0.5255	0.7487	0.9819	1.2444	1.4898	1.9941
Weight, per ft.	2.5	3.5	4.75	6.	8.	9.
Safe internal pressure, per square inch	220	164	135	110	104	69

LEAD PIPE
Extra, Extra Strong, A. A. A.

Actual outside diameter..	1.04	1.27	1.50	1.83	2.15	2.61
*Calculated inside diameter	0.5542	0.7617	0.9895	1.2674	1.5163	2.0011
Weight, per foot.	3.	4.	6.	6.75	9.	10⅞
Safe internal pressure, per square inch	233	178	162	118	111	81

MUELLER COPPER PIPE

Outside diameter	⅝	⅞	1⅛	1⅜	1⅝	2⅛
Thickness B. W. G.	18	16	16	16	15	14
Thickness in inches	.049	.065	.065	.065	.072	.083
Safe internal pressure, per square inch	744	698	523	418	389	301

*Based on outside diameter and weight.

* Paper before the American Water Works Association.
† Consulting engineer, Reading, Pa.

shall be either galvanized, wrought or malleable iron, lead-lined wrought or malleable iron, or cast iron. The first elbow shall be attached to the corporation cock and followed with nipple, union and second elbow for a distance of approximately nine diameters of the pipe from center to center of elbows. The direction of this portion of the connection shall be approximately in line with the water main. The next portion of the connection shall consist of a nipple and a third elbow and be not less than six diameters in length, between elbow centers, and shall extend upwards or downwards to reach the proper depth of the service pipe. The outlet of the third elbow shall run at right angles with the main."

The corporation cock for these installations was inserted horizontally on the side of the main pipe line. It was and is now rather difficult to purchase long-turn elbows, because so few supply-houses keep them in stock. So, after a trench had been left open for several days while the plumber was endeavoring to get hold of some long-turn elbows, the nuisance of the open trench was abated by permitting the plumber to substitute short-turn elbows, which, with three of them in the line rather closely bunched, did not aid the flow of water greatly by reason of the excess friction created.

The copper service pipes and connections, recently put upon the market by one of the largest manufacturers of water works brass goods, have demonstrated their great value as mediums for joining service lines to corporation cocks as well as good materials for the service pipes. Note the strength of these pipes in the accompanying table and compare them with corresponding sizes of lead pipes. The strength to resist internal pressure is way above the actual requirements; brought about, no doubt, by an added thickness of metal for withstanding external pressures.

Sizes up to and including one-inch in diameter have been on the market and in use for some time.

COPPER GOOSE NECK

In the opinion of the writer the proper materials for service pipes and goose-necks of the various sizes are as listed below. The materials are listed in the order of preference. The list does not contain cement-lined pipe, because the writer has had no experience with it.

Diameter in inches	Materials of Service Pipes	Materials for Goose-necks
½, ¾ and 1	Copper or brass, lead, lead or tin-lined genuine wrought-iron, genuine galvanized wrought iron.	Copper or lead
1¼, 1½ and 2	Copper or brass, cast iron*, lead or tin-lined genuine wrought iron, genuine galvanized wrought iron.	Copper
Above 2	Cast iron, genuine galvanized wrought-iron.	No Goose Necks

*If made heavy enough to withstand external forces, including rough handling.

Iodizing Public Water Supplies

"The theory that endemic goiter is due principally, if not solely, to a relative or absolute deficiency of iodine is now widely accepted. The experimental evidence upon which this conception is based is so convincing and the practical applications are so successful that doubts concerning the tenability of the theory are steadily being dispelled."

With this paragraph, Robert Olesen, surgeon, U. S. Pubic Health Service, begins an article on "Iodization of Public Water Supplies for Prevention of Endemic Goiter" in the May issue of "Public Health Reports." He discusses at length the theory and practice of goiter prophylaxis, especially with public water supplies as a medium. In spite of the considerable discussion of this procedure for four years past, there are but two cities in this country, Rochester, N. Y., and Anaconda, Mont., where it is practiced, so far as he has been able to learn. It was practiced for a short time in Sault Ste. Marie, Mich., and Virginia, Minn., but was speedily abandoned.

His conclusions relative to desirability of iodizing public water supplies are as follows:

"The iodization of public water supplies, in its present state of development, can not be recommended for widespread adoption. However, the measure appears to be theoretically sound and promising as a means of reducing goiter incidence when correctly used. The chief points in its favor are its comparatively low per capita cost, its apparent harmlessness even to existing goiters, and its wide range of applicability.

"So far, there is considerable doubt as to the ability of iodized water to reduce the incidence of endemic goiter. This important point should be clearly established before further commendation of the measure can be forthcoming. However, the lack of convincing evidence of the efficiency of iodized water appears to be the result of poorly controlled experimental applications, rather than any inherent defect of the procedure itself.

"While the measure can not be recommended for wider use until stronger evidence concerning its value is forthcoming, nevertheless, iodized water should not be condemned as worthless. Rather there is need for more precise experimental work, with careful and repeated thyroid examinations, both of children as well as adults. Comprehensive control experiments in nearby communities, among groups which are not consuming iodized water, are also essential. In conjunction with these precautions, it is also desirable that epidemiological observations be made for the purpose of learning whether other iodine preparations are being used. The results of such scientifically performed experiments would readily disclose the worth or worthlessness of iodized drinking water as a means of preventing simple goiter."

Advantages of Electrically Driven Pumps*

Some of the most interesting and practical engineering studies are presented by municipal pumping enterprises. Steam direct, steam-electric, oil engine, electric or purchased power for electric drive all have to be considered and settled after carefully weighing all the complex conditions that bear upon the answer.

Where central station power is available, the large generating station has a great advantage as 1½ to 2 pounds of good coal will generate 1 k.w.h. whereas the small station will require 3 to 6 pounds of coal per k.w.h., and much greater operating cost per k.w.h. as well. It is apparent that except in the very largest cities, the cost of municipalities making their own current will be much higher than purchased power. An argument used at one time, which had much weight, referred to the reliability of the municipality owning the station or at least the desirability of a private plant as a standby in case of failure of the public supply. This argument has less and less force as the years have gone on. Reserve units in the central station, interconnection with other hydro and steam stations and adequate lightning protection have all worked to make even a momentary "out" a very unusual occurrence. Today "power off" is far less likely to occur on a power system than on even the most carefully supervised small plant.

Among the prominent synchronous motor installations are those at New Orleans, Louisiana, Albany, New York, Duluth, St. Paul and Lansing. Wheeling, West Virginia, has 700, 900 and 1300 h.p. units of the wound rotor, induction motor design in successful operation. The city of Detroit has one of the most efficient pumping units that we know of where the overall efficiency "wire to water" is 84% on a 70,000,000 gallon centrifugal pump driven by 2600 h.p. synchronous motor.

Some comparisons of operating costs of various types of drives as compiled by consulting engineers and others may be of interest.

Filtration plant pumps at Albany, New York, were changed from steam to electric drive on purchased power with a saving of $30,000 per year for the past six years.

The cost of pumping per million gallons at Savannah, Ga., was cut from $65 for the steam system to $10 for the electric system.

Annual operation and repair cost on a 24,000,000 gallon electric station in Chicago are $3,000 as against $16,000 to $20,000 for similar steam station operating at the same time.

Turbine pumps, reciprocating pumps and, as a matter of fact, each kind of pump has its special field, but in recent years the tendency has been toward electrically driven pumps where local conditions permit. The great increase in the ratio of electrically driven pumps to pumps driven by other means may be said to be due to the following:

The transmission of power at high speed naturally means low torque and small dimensions in general, with consequent low weight and cost.

The installation of an electrically driven pump is a comparatively simple matter, as to foundation, piping and wiring. Such pumps can be installed in convenient places over a wide area without material loss or energy in transmission.

The control for motor driven pumps can be designed for every possible condition of operation, giving an option on hand or automatic, adjacent or remote control.

Speed variation, heavy starting duty and adequate protection may be provided for.

The power consumed by an individual pump may be indicated by its ammeter or watt-hour meter, making it easy to detect abnormal or misfit conditions.

*Extract from a paper before the Southeastern Water and Light Association, by A. W. Baker, of the General Electric Co., Atlanta, Ga.

Surface Treatment of Gravel and Stone Roads*

By C. C. Newson†

In order to reduce maintenance charges and eliminate the dust nuisance, it was decided to surface treat about 12.6 miles of gravel road between Lebanon and Frankfort, Indiana. The old road bed averaged about twenty to twenty-two feet in total width, which was hardly enough to permit twenty feet of treated surface and still leave sufficient shoulder to hold the metal base. Rights of way to allow widening were obtained in most places, and this defect corrected where possible.

Early in the spring, work in getting the gravel base into shape was begun by patching the weak places and by eliminating the many waves which had been in the surface for some time. However, the spring thaws disclosed the fact that nearly fifty percent of the road had broken up. It was thought that there was eight or ten inches of gravel on the road, but it was found that in many places there was not more than four inches.

Owing to the condition of the road, it was decided that the entire length would have to be resurfaced in order to get sufficient base to withstand heavy traffic and make the road suitable for the proposed surface treatment. This was done, using 1¼ to 2½-inch crushed limestone as a base course. No standard depth of stone was placed, the amount used depending on the condition of the particular stretch of road on which it was placed. In some places, 12 to 15 inches of stone was used.

The stone was placed by our own trucks, and was distributed as evenly as possible, taking into consideration that more was needed in some places than

*Abstract of paper delivered at thirteenth annual road school, Purdue University.

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in others. It was deemed desirable to bring up the low spots rather than do any extensive scarifying or cutting off of high places. The only scarifying was in places where the old surface of the road was caked and hard; these spots were loosened up to the depth of about an inch, so as to give a small amount of loose material to hold the stone.

After the stone had been placed, it was smoothed down with a drag or a combination tractor and grader outfit, after which it was rolled with a ten-ton roller continuously, since this was found preferable to going long distances before turning. After the first rolling, a few low places were noticeable and these were filled with stone and rerolled. Traffic was not interrupted, which resulted in some loosening of stone, and emphasized the necessity of continuous rolling.

The metal was confined to the width to be treated —about 20 feet—by throwing up berms. These become mutilated by traffic turning out on to the shoulders, but should be repaired and kept lined up.

No binder material was applied until all the heavy material was on the road, the aim being to get a hard but somewhat porous surface. Some difficulty was encountered from soft, seepy places underneath the surfacing. Large stone was added to these places without much success; finally the clay was dug out and the depression filled with dry stone.

Gravel was then placed on the surface. Both washed and dipped pit gravel were used, and both appeared to be fairly satisfactory. In dragging the gravel, a long drag is essential to take out the waves. On this work, a 4-bladed drag of the wooden type, 24 feet long and 8 feet wide, was used. This required a ten-ton tractor, but proved very valuable in eliminating waves and dips less than 10 or 15 feet long. A 12-foot grader also proved valuable in this work.

It required 8,800 cubic yards of stone, 3,400 cubic yards of washed and plant gravel, and 1,500 cubic yards of local gravel for the 12.6 miles, or an average of 1,906 cubic yards of all material per mile.

For surface binder, light tar, known as TC in the state specifications, was used. This was shipped in tank cars, which were measured to determine the gallonage, and the temperature taken before unloading. Since other provisions were made for testing, it was not necessary to take samples, except that from every fifth car ⅓ of a quart was taken from the top, center, and bottom, mixed and sent in as a check sample.

The distributor used was of the pressure type and had a capacity of 750 gallons. It was equipped with an oil heater, and the oil was applied at a temperature of 115° to 120° F.

Our method of applying the tar was as follows: One half of the road, or about 10 feet in width, was treated at a time. The first application was made on the loose gravel or stone surface (after the twenty foot roadway had been given the proper crown with our crowning drag), three-eighths of a gallon per sq. yd. being applied. One distributor load covered about 2,000 square yards or 1,800 linear feet for a 10 foot strip.

After the first application had been allowed to penetrate for 1 to 1½ hours, the loose material was scraped or turned from one half the road over to the other half, leaving the hard bare surface exposed. It was found to be advisable, when scraping the loose material from one side to the other, to get well beyond the center line of the road in order that the distributor would cover the entire width with the two spreads on the bare surface. The scraping of this loose material was done with a grader pulled by a truck, care being taken not to get beyond the gravel or stone line at the edge of the road and in so doing get some dirt mixed with the gravel and stone.

Three-eighths of a gallon per square yard was applied as a second coat on the surface that had been scraped bare of the loose material. After this application had been allowed to penetrate for one and one-half to two hours, the scraping method was reversed and the loose material from the other side was moved over to a point just beyond the center-line of the road.

There was now a ridge of loose material, mixed with tar, near the center of the road, and we were ready to apply the second coat of tar on the second half of the bare road. This completed the first eighteen hundred lineal feet of road as far as the application of the tar was concerned, except for a little spotting up, which was done after the road had been finished.

After not less than two hours, we were ready to spread the ridge of tar-coated gravel and stone over the entire 20 feet of treated surface. It is very essential that this material be spread uniformly and to a uniform depth over the surface. In doing this, we first used a No. 7 grader with a 12-ft. moldboard. The blade was set at right angles to the road and to the grader itself, which allowed it to spread the ridge evenly on each side of the center line of the road. The first trip with the grader did not get the material entirely out to the edge of the treated surface and it was necessary to make two or more trips over the surface to insure a fairly even distribution of the stone and gravel. After this treatment, the loose material was about 1 to 1½ inches deep over the entire surface, but was not true to the crown of the road and therefore not ready to be rolled.

A home-made wooden crowning drag, which had two parallel blades about 6 feet apart and twenty feet long, or just the right length to reach over the entire width of the treated surface, was then used. The blades were cut to conform to the desired crown, in this case making the center of the road 2½ inches higher than the outside edges. This drag was then pulled very slowly with a truck, great care being taken to keep the center line of the drag in the center line of the road. Two men followed the truck, in front of the drag, and with shovels kept the loose material evenly distributed along the front face of the blades of the drag, causing the surface to be uniform and true to crown. It is very important not to have a shoulder on either side of the metal that is higher than the metal itself. If such is the case, the ends of the drag will ride this high surface and destroy the uniform crown, which is so essential to the success of the work. If water is allowed to stand on the finished treated surface, it will

destroy the life of the tar and cause it to disintegrate in a short time, hence the importance of not having a high shoulder. We ran a grader ahead of the distributor and cut the shoulders down where necessary.

After we had pulled our crowning drag over the surface three times, a ten-ton roller was used to roll the finished surface, beginning at the outer edge of the road. Sometimes when the loose material is a little light near the shoulders and the tar a little heavy, the roller will tend to pick up the mat. This usually can be avoided by putting a small amount of water on the wheels of the roller; but if the tar still seems to pick up under the roller, it is best to stay off this particular part of the road until some loose dry material can be sprinkled over the surface. It is very important to do plenty of rolling; one roller can easily do this and keep up with one distributor.

After the surface had been thoroughly rolled, we allowed traffic to use it the day after it was completed. It is better to try to finish completely, by the end of the day, the stretch of road begun in the morning. If the treated material is allowed to lie in a ridge, or even allowed to lie over night with only the first coat of tar applied, it will set to a certain degree and will not work as well nor give as good results as if worked when first applied. Material should never be allowed to lie over Sunday. It so happened that we were compelled to do this in one or two instances, with the result that this part of the road so treated proved to be too dry and it was necessary to apply a third coat of tar later, which extra coat of tar may be a source of trouble later.

In order to avoid pick-ups of the mat, we had a few stock piles of gravel and stone, principally stone, placed along the roadside to apply on the bleeding places, which are sure to develop with this kind of surface treatment. Very little gravel was used, since we found that ⅞-inch or even 1-inch stone, free from dust, answered the purpose much better. We placed this stone on the bleeding surfaces with a truck if the space was long enough to use a truck load, otherwise it was done by hand. A truck load of three yards covered 1,500 to 2,000 lineal feet of road for a width of one-half the road.

We also had a few barrels of tar stored along the road to take care of the spots that seemed to be too dry or spots where the mat had begun to ravel. We sprinkled the tar over the dry spots, covering it with a very light coat of stone chips. Where holes developed, we patched these with a lean mixture of stone and tar.

After the tar had been down on the road for a few weeks, we noticed that in a few places the mat was rolling or pushing ahead of the traffic. This indicated that there was too much tar at these places, too heavy a mat of loose material, or an excess of sand in the gravel. In most cases the cause was too much tar and too much sand. To remedy this, we spread ⅞-inch and 1-inch stone over these places, letting the traffic pack it into the tar mat.

In many places this was not done until too late, as the shoving and waving had already developed, but when repeated a second or third time reasonably good results were obtained. In one or two instances, where the shoving was excessive, the high places were cut off with a grader. Examination showed that the mat at these places had not adhered to the hard base of the road, and in some places it was found necessary to remove it entirely.

Our experience on this job taught us the following:

(1) An excess of tar will cause a shoving and waving in the surface, while an insufficient amount of tar will cause raveling.

(2) It is easier to correct the deficiency in the tar than it is to correct the excess, as it is always possible to add a small amount of additional tar if there is a deficiency in the amount applied.

(3) The condition due to excess tar can be corrected by repeated covering of the surface with comparatively coarse covering material, ¾-inch to 1¼-inch, permitting the traffic to hammer the covering into the soft surface. If this is done frequently enough, it appears that the waving and shoving resulting from an excess of tar can be greatly reduced, if not eliminated.

The following is an estimate of the cost per mile of work described, not including the building up of the sub-base, which was necessary whether we treated the surface or not:

250 cubic yards gravel applied prior to treating..	$625
Dragging and preparing the surface for tar.....	100
8,700 gal. tar applied, 20 ft. wide.....	1000
Labor rolling and smoothing treated surface.....	150
30 cubic yards stone applied as covering coat.....	75
Total cost.	$1950

It may be interesting to note the difference in maintenance cost per mile of this section of road for six months after the surface treatment as compared with the maintenance cost for the six months prior to treatment.

Six months prior to treatment	
200 cubic yards gravel applied	$500
Labor dragging daily at $1.50 per mile.....	175
Miscellaneous expenditures.....	25
Total cost.	$700

Six months after treatment	
50 cubic yards covering applied.....	125
50 gal. tar	10
Labor patching small holes and miscellaneous work	75
Total cost.	$210

Comparing the cost mentioned and considering the benefits of a dustless road to the traveling public, we feel that a surface treated road is an economical investment.

Woodward Avenue Street Lighting System

An unusual method of street lighting has recently been installed on a portion of Woodward Avenue, Detroit, which has recently been widened throughout the greater part of its length to 204 feet, making it one of the world's widest highways.

In order to assure night-time safety for the increased traffic which would naturally gravitate to such a highway, some 300 new lights have been installed. These are Westinghouse "Luxsolite" units, furnished with Mazda lamps of 1500 candle power, enclosed in globes of bluish tinted glass producing

a daylight effect. The outer surface of the globes has a rectilinear finish which gives sparkling appearance when lighted.

These new lights replace the old arc lights formerly installed on this thoroughfare . They extend for four and one-half miles through the more congested section of Detroit. It is expected that they will ultimately be extended the entire length of Woodward Avenue when the street widening now under way is completed.

Sewage Chlorination at Fort Worth

Advantage of chlorinating sprinkling filter effluents at inlet to secondary tanks instead of outlet. Apparently improved final effluent

By W. S. Mahlie*

During August, 1926, there was begun, at the sewage disposal plant of the city of Fort Worth, a set of experiments upon the chlorination of sewage which were designed to determine what advantage chlorination of sprinkling filter effluents at the inlet side of secondary settling tanks might possess over the more customary practice of chlorinating the effluents of such tanks.

This plant consists of bar screens, grit chambers, a pumping station, Imhoff tanks, sprinkling filters, and two secondary sedimentation tanks with Dorr clarifiers. During the experiment, chlorine was applied to the filter effluent as it flowed into one secondary settling tank but not to the other. Composite samples of effluent made up of hourly samples taken over the entire 24 hours were collected from each tank and analyses made for the purpose of comparing the performance of the two tanks. The chlorine was applied by means of Wallace & Tiernan chlorinators, the chlorine bubbling through two diffusers placed in the influent channel, submerged to a depth of about two feet. This was the greatest depth we could obtain and because of the shallow depth some of the chlorine escaped into the air and there was a noticeable chlorine odor at this point.

The test embraced 14 runs of 24 hours each, divided into a series A of 9 runs to represent summer conditions and series B of 5 runs to represent winter conditions. Tables one and two show the result during the summer and winter conditions respectively. Averages only are given. Comparisons of day-by-day results in the two tanks show apparent inconsistencies due probably to the non-synchronous occurrence of eructations of sludge and other activities of the tanks, although it is probable that the averages of these activities over a period of days or weeks would be the same for the two tanks under similar conditions as to chlorine application.

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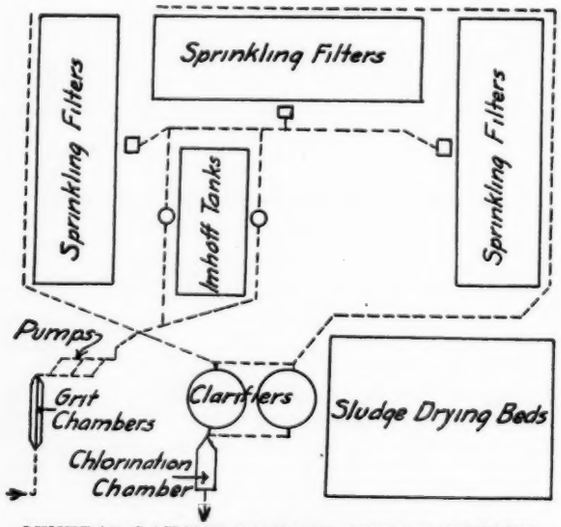

GENERAL LAYOUT OF FORT WORTH SEWAGE DISPOSAL PLANT

CHLORINE DEMAND OF SEWAGE

It has been found that the chlorine demand of sewage varies considerably over wide ranges. This is influenced by the following constituents of the sewage, probably in the order named: 1, gas; 2, liquids; 3, solids. In any chemical reaction it is apparent that the speed of the reaction varies directly as the reacting surfaces exposed, and in the chlorination of sewage it would therefore be expected that, all other constituents being identical, the sewage containing the larger amount of reducing gases would have the greater chlorine demand.

The predominating gases in sewage are hydrogen sulphide, methane, ammonia and carbon dioxide. The first three readily combine with chlorine and any condition which would tend to favor greater production of hydrogen sulphide or methane in sewage would necessarily increase the chlorine demand. The influence of septicity can easily be seen.

The Fort Worth sewers receive screened and settled packing house waste combined with domestic sewage, giving a highly concentrated sewage which reaches the plant in a fairly fresh condition. The chlorine demand of the raw sewage is found to be 9.4 p.p.m.; that of the Imhoff tank effluents approximately the same; the sprinkling filter effluents 3.5 p.p.m.; and that of the final clarified effluents, approximately the same. It is obvious that the concentration of dissolved oxidizable organic matter present in sewage is one of the controlling factors of chlorine requirement.

Since chlorine would unite first with the gases, it is apparent that odors can be reduced by chlorine application even though there is insufficient chlorine applied to produce residual chlorine in the treated sewage.

It would seem that gas demand and liquid demand must first be satisfied before any appreciable bacterial removal will occur, since most of the bac-

TABLE I—BACTERIA—THOUSANDS PER CUBIC CENTIMETER

No.	Date	Filter Effluent		Clarifier Effluent Non-Chlorinated		Clarifier Effluent Pre-Chlorinated		Cl. App. P.P.M.	Cl. Residua.
		Total	B. Coli.	Total	B. Coli.	Total	B. Coli.		
1	Aug. 31, 1926	850	10	650	10	300.	10.	2.95	0
2	Sept. 1, 1926	1,000	100	1,300	100	3,000.	100.0	3.72	tr.
3	Sept. 2, 1926	2,000	100	1,900	1,000	.250	.01	3.37	tr.
4	Sept. 3, 1926	750	10	1,700	100	.475	.01	2.38	0
5	Sept. 10, 1926	2,500	1,000	3,900	100	1.	.01	3.12	0
6	Sept. 14, 1926	2,400	100	1,300	100	290.	1.	2.86	tr.
7	Sept. 15, 1926	1,100	10	2,100	10	1,700.	10.	1.62	?
8	Sept. 16, 1926	970	100	2,500	1,000	3,800.	10.	1.77	0
9	Sept. 17, 1926	2,100	10	4,800	10	380.	10.	1.68	0
10	Jan. 4, 1927	1,200	100	1,200	100	14.5	1.	1.69	tr.
11	Jan. 5, 1927	300	10	590	100	4.4	.1	2.79	tr.
12	Jan. 5, 1927	550	100	260	100	2.5	.1	2.24	tr.
13	Jan. 7, 1927	700	100	1,400	100	1.5	.01	2.53	0
14	Jan. 8. 1927	550	100	650	100	.75	.1	2.28	tr.
	Average	1,212	132	1,732	209	678.	10.17	2.50	

Average amount treated daily 2,516,000 gallons.
Average chlorine demand of filter effluent = 3.5 P.P.M.

TABLE II—AVERAGE CHARACTERISTICS OF SEWAGE TREATED

Parts Per Million

	Raw	Imhoff effluent	Filter effluent	Clarifier effluent non-chlorinated	Clarifier effluent chlorinated	Per cent. removed by clarifier non-chlorinated	Per cent. removed by clarifier chlorinated
Series "A" (Summer)							
Suspended solids	302	126	84	80	41	5	51
Non-setteable solids	118	87	34	55	29	62 Increase	15
Settleable solids, C. C. per liter	5.67	.56	2.47	1.57	57	36	78
Ammonia nitrogen	31.1	33.9	9.4	11.4	9.2	21 Increase	2
Total organic nitrogen	41.6	27.0	15.3	12.1	9.7	21	37
Nitrite nitrogen	0	0	2.1	2.7	1.4	29 Increase	33
Nitrate nitrogen	0	0	3.9	2.0	3.8	49	3
Oxygen consumed	147	109	64	58	52	9	19
Dissolved oxygen	0	0	1.2	.6	3.6	50	200 Increase
1-Day oxygen demand	370	292	35	24	14	31	60
5-Day oxygen demand	653	501	80	63	39	21	51
Chlorides	607	611	598	598	601	..	..
Total alkalinity	422	422	337	340	337	..	..
Series "B" (Winter)							
Suspended solids	320	172	110	48	36	56	67
Non-settleable solids	121	87	26	25	23	4	12
Settleable solids, C. C. per liter	5.60	.86	3.56	.66	144	81	88 17
Ammonia nitrogen	32.8	33.2	11.8	11.6	13.8	2	Increase
Total organic nitrogen	29.8	18.8	11.6	8.6	8.0	26 13	31 Increase
Nitrite nitrogen	0	0	2.3	2.6	.8	Increase	65
Nitrate nitrogen	0	0	5.3	3.6	4.5	32	15
Oxygen consumed	141	105	55	44	45	20	18 154
Dissolved oxygen	0	0	1.3	1.1	3.3	15	Increase
1-Day oxygen demand	324	240	34	18	16	47	53
5-Day oxygen demand	536	402	82	37	41	55	50
Chlorides	426	....	..	..	..	..	..
Total alkalinity	444	436	339	340	352	..	..

teria are found in clumps or imbedded in particles of finely divided organic matter in suspension. It could hardly be expected that truly effective bacterial reduction can be secured unless residual chlorine is maintained in the treated sewage, and the control of sewage sterilization should therefore be effected through the maintenance of residual chlorine, which may best be determined by the ortho-tolidin test.

In estimating chlorine demand of sewage it is not permissible to add an excess of chlorine solution and then, by means of a back titration, measure the unconsumed chlorine and consider the difference the chlorine demand. The method employed in these studies was to add measured amounts of a standardized chlorine solution to the sewage, let it react for 10 minutes and test for residual chlorine, and add more if necessary until free chlorine is obtained.

BACTERIAL CHANGES DUE TO CHLORINATION

Table II, giving averages of the 14 runs, shows that there was an increase in total bacteria and B coli between the inlet and outlet of the clarifier which received no chlorine at the inlet, but in that receiving chlorinated effluent there was a reduction of 44 per cent. total bacteria and 92 per cent. B. coli. The increase in the former was no doubt due to a slight amount of septicity developing in the clarifier and eructation of gas-laden sludge containing hordes of bacteria. The filters were unloading continually and a small amount of solids settled on the sweeping mechanism and small depressions in the bottom of the tank and became septic, although the sweeping mechanism was run continuously.

Except for tests Nos. 2 and 10, the bacterial reduction in the chlorinated clarifier bears a direct relation to the amount of chlorine applied and to the presence of residual chlorine at the influent end of the clarifier.

All of the bacteria surviving chlorination appeared to be of the same general nature, resembling B. subtilis, which is characterized by ability to form spores and resist destruction.

EFFECT ON SUSPENDED SOLIDS

The increase in removal of solids, and especially of non-settleable solids when chlorine was applied, is shown in Table II. In the effluent from the non-chlorinated clarifier the non-settleable solids amounted to 69 per cent. of the total in summer and

but 52 per cent. in winter, indicating increased septicity in summer: non-settleable solids increasing during passage through the clarifier in summer but not in winter.

Examination of the data confirms the supposition that biological activity in secondary tanks tends to produce an inferior effluent, and retardation of such activity by pre-chlorination had considerable influence in reducing the suspended solids leaving the secondary tank and the spasmodic occurrence of them.

EFFECT ON NITROGEN AND OXYGEN BALANCE

Chlorination appeared to retard or prevent increase in free ammonia during passage through the clarifier; to increase removal of total organic nitrogen content; and to prevent loss of nitrate nitrogen (a loss caused by reducing organisms in the tanks) and consequent reduction in stability.

Pre-chlorination lowered the oxygen consumed value; also increased the dissolved oxygen (apparently at the expense of the nitrates) more in summer than in winter.

The bio-chemical oxygen demand values of the effluents from the chlorinated and non-chlorinated tanks differed little in winter, but in summer both the one-day and the five-day demand were markedly less in the former as a result of retardation of septic action.

EFFECT ON ALGAE

At the beginning of these tests there was quite an appreciable growth of algae on the inlet and outlet weirs of the clarifier, but this disappeared immediately after commencing to chlorinate.

The above are preliminary conclusions from a superficial study of the problem, but it is believed it may serve as a basis for future study by those interested. Acknowledgement is made to the Chlorine Institute which, through L. H. Enslow, research engineer of the institute, furnished the chlorine for these experiments; to Edgar Whedbee, district engineer of the Texas State Board of Health, who assisted in the test and preparation of the report; and to Carroll Green of Fort Worth, who made the chemical analyses.

Operating Rapid Sand Filters*

Practical suggestions for operators, describing details of practice in controling coagulation, sedimentation and filtration; discussing air-bound filters, mud balls, operation of valves, controllers and other appliances, and analytical tests.

By S. T. Powell †

COAGULATION

Chemicals are fed either in a dry state or as a solution. Filter efficiency depends largely upon proper control in feeding the coagulant. No definite scale of treatment satisfactory for all water supplies is possible. The chemical properties of different waters vary greatly and the quality of even the same water varies from season to season and frequently from day to day. Exact treatment may be determined only by careful observation, utilizing the experience gained in this manner for proper control.

One of the most satisfactory methods for determining the proper doses of coagulant to be applied to the water is the so-called "jar treatment." Small samples of the untreated water are dosed with various amounts of the chemicals. The samples are stirred for a short time and then set aside and the rate of floc formation and the character of the coagulated material noted. Wherever possible, the jars should be placed so that the light will shine through the water. Careful observation will indicate the dosage of chemical to give the most satisfactory plant treatment. The control of many plants is carried on in this way and excellent results are obtained.

Some experienced operators adjust the chemical dosage by observation of the floc as the water flows to the filters. When the water contains very finely divided suspended matter termed by some operators "smoke," improper coagulation is indicated, while, if the floc appears to be suspended in clear water, good filtration is possible. Filter operators may acquire considerable experience in this respect by frequent observation of the treated water. The same condition may be noted equally well at night by submerging an electric light or flash light into the water or by directing a beam of light through a clear glass containing the treated water.

It is not only necessary to determine the proper amount of chemical to be applied to the water but it is equally important that the equipment for feeding the chemical functions satisfactorily. If the plant is equipped with a dry feed machine, the apparatus should be checked frequently to determine if it is properly calibrated. Clogging or stoppage described as "freezing" is the difficulty most frequently encountered.

Where liquid or solution feed of chemical is used, stoppage of the orifice that regulates the flow results often in improper treatment. Alum and other chemical solutions should be stirred frequently or preferably stirred continuously by mechanically operated paddles. Irregular plant operation may be traced more frequently to statification of chemical solutions than to any other single fault. Chemical storage tanks and feeding devices should be cleaned out at intervals, since filter alum and other coagulants contain an appreciable amount of insoluble material that forms sludge which interferes with accurate doses of the chemicals.

BASINS

The purpose of sedimentation basins is to permit

*Paper before the First Annual Conference of the Maryland Water and Sewage Plant Operators, omitting introductory matter.

†Division engineer, Maryland State Department of Health.

the removal of suspended material from the water prior to filtration, thereby reducing the load on the sand bed, lengthening the time between cleaning the units and effecting other incidental improvements in operation. The time between cleaning the basins should be governed entirely by the nature and amount of the accumulation in these tanks. Too frequent cleaning of basins results in an unwarranted waste of water, while too infrequent removal of these deposits may cause serious operating troubles. Sludge deposits should never be permitted to accumulate to the point where the water flowing through the basins will reentrain these solids and carry them to the filter. Where the deposited sludge in the settling basin contains much organic matter, difficulty may be experienced from redissolving of the floc, excessive gas formation, algae growths, tastes and odors and numerous other annoyances. Whenever any of these problems are encountered, especially during warm weather, it is desirable to clean the basin if there is any appreciable amount of accumulated mud deposits.

Whenever sedimentation basins are emptied for cleaning, careful inspection should be made of the inlet and effluent control gates, leaks in walls or floor of the tanks and leaks in the chemical lines. Many lapses in improperly operated plants may be traced to leaks in chemical lines that discharge the solution in the basin at a considerable distance from the designed point of application, thereby losing the desired effect of mixing and reducing subsidence periods.

FILTER BED

The most important part of a filter is the sand bed. Lack of attention to this portion of the system is certain to result soon or late in inefficient control. All sand beds should be drained and inspected each month and the operator should observe the bed during each washing and note any irregularity in the washing operation, since much may be learned concerning the condition of the units during this operation. Mud ball formation is probably the most baffling and annoying operating difficulty that is to be encountered in filter plant control. This problem is present at all plants to a greater or less degree and no practical solution has yet been devised that will ensure complete elimination of the trouble. As the term indicates, mud balls are solid areas of mud originating in small patches. These deposits grow in size and, if not controlled, completely cover the area of the bed, penetrating the entire depth of the filter.

Mud Balls. Effective distribution of wash water, careful spacing of wash water troughs, good grades of sand and proper grading of the filter medium will do much to lessen these mud spots, but will not ensure complete elimination of the deposits. The maintenance of filter beds in proper condition in respect to mud ball formation is an operation problem and may be controlled largely in this way. Filters should be drained at regular intervals and inspected. Where patches of mud balls are noted on the surface of the bed, they should be removed by hand scraping. Where the mud balls have penetrated into the sand bed, it may be necessary to back wash the unit several times, scraping after each washing. In extreme cases, it is necessary to remove the upper layer of the sand bed or remove the entire bed and re-sand the units.

Mud ball formation is detrimental to efficient operation in many respects These deposits are dense and almost entirely impervious to water. For this reason, little or no water passes through them, so that in order to maintain the desired rate through a given area, excessive rates must be maintained in the portion of the bed free from these accumulations. In addition to this failure, these deposits are a source of excessive bacterial pollution and impart a disagreeable taste to the filtered water.

Uneven distribution of wash water is in many cases responsible for poor filter performance. This trouble seldom occurs in new filters that have been properly designed, but may occur after a few years' service. The trouble is caused by displacement of the gravel bed, blown off strainer heads, split pipes or other failures. An alert operator can observe the difficulty as soon as it happens by watching the distribution of the wash water during the back washing of the units. The condition is indicated by a spouting of wash water in the bed directly over the spot where the failure of the underdraining system has occurred.

Air-bound Filters—Probably air binding of filters is responsible for more poor filter results than any other single cause, but it is likewise less understood by the individual operator. To understand this phenomenon, it is necessary to review briefly the theory of the solution of gases in water or other liquid. Oxygen, carbon-dioxide and other gases normally present in air dissolve in water. The amount of the gases that can be taken into solution depends upon the temperature of the liquid and the pressure on the gas and water. Considering for the time only the effect of temperature, the colder the water the greater the amount of gas that will dissolve in it. As the water is heated the gas (air) dissolved in it cannot remain in solution and is released.

When cold water enters a filtration system and passes through the filter bed, the temperature of the water is raised and the gas escapes into the sand bed. Since the water is flowing through the bed the released gas does not rise unless the volume becomes very great or the process is stopped, thus permitting the gas to pass upward through the filter medium. Trapping the gas in the filter medium causes a marked reduction in the rate of filtration and in extreme cases complete stoppage of the flow of water through the filter. The speaker has experienced cases of this kind where the filtration was stopped completely fifty minutes after the unit had been put into service.

When air-bound filters are unwatered the entrained gas rises upward through the bed due to its buoyancy and in so doing perforates the bed. If the unit is put back into service again without washing, poor filtration will result since the filter bed is filled with small holes.

Where air binding is prevalent, short back washing periods at frequent intervals will greatly relieve the trouble. Air binding is more prevalent in winter than during the summer months, but may be encountered in some localities during warm weather. When the conditions occur during the latter period, it is traceable usually to prolific algae growths or

similar micro-organisms, since these aquatic plants during their growth give off oxygen. Under some extreme conditions, the supersaturation of dissolved oxygen due to this cause may rise to 200 per cent.

Operation of Valves.—It is difficult to impress upon filter plant operators the importance of opening and closing all valves slowly. There is no single operation in the plant that should be carried out more carefully. Rapid opening of the filter effluent valves results in a violent shock to the filter, causing holes and channels in the sand bed. This causes not only poor filter efficiency, but may permanently injure the bed by drawing the floc or even sand into the underdrainage system.

Sudden admission of wash water to the bed due to rapid opening of the wash water valve may do much damage to the underdrainage system. This is certain to result with shallow gravel beds and when the bed is composed of small sizes of stone or gravel. Especially is this true where the filter contains an appreciable quantity of entrained air in the bed. The speaker has noted conditions of this kind where the gravel has been carried upward through the sand bed and strainer heads had been sheared from the laterals. Some designing engineers are eliminating these possibilities by installing slow opening valves.

CONTROLLERS, GAUGES AND SIMILAR APPURTENANCES

Controllers, whether they are the simple ball float valve or more elaborate appliances, are installed to maintain relatively constant rates of flow of water through the filter. Sudden changes in filtration rates are detrimental to efficient operation. The majority of these equipments are fairly rugged and function satisfactorily with little adjustment. They should be inspected at intervals, however, and, when found to be out of adjustment or otherwise at fault, they should be overhauled.

Gauges and appliances equipped with recording charts should be kept in working order and the charts changed when necessary. Charts should never be used so that they overlap beyond their designated indicated period. Charts removed from the gauges should be dated and filed for future reference. The proper use of recording charts from correctly calibrated instruments is of much value for efficient plant operation.

Sight glasses or filtered water sight control appliances are of assistance in determining how the individual filter units are acting. There are many different designs of appurtenances of this kind. They all serve the same general purpose, namely, to indicate the relative filter efficiency as shown by the clearness of the filtered water. If these appliances are to serve the purpose for which thy are intended, they should be kept clean at all times. It is desirable, also, that the glass container be replaced from time to time with new units, since even good glass in time is affected by the action of the water and the observed condition of the water is misleading due to the roughened appearance of the glass.

Sight glasses are employed at times as combination indicator glasses and for sampling devices. Where they serve this dual purpose, care should be used to clean them frequently, since bacterial growth may occur in them with misleading results. Only high resistant glass (Pyrex) should be employed, since the alkalinity of the water is materially affected due to the solubility of the sodium salts in ordinary glass. Care should be taken especially in this respect, if the samples drawn from these glasses are for the determination of hydrogen-ion concentration of the water.

ANALYTICAL TESTS

No plant can be operated efficiently and economically without frequent testing of the raw and treated water and control of the system by means of these analytical data. The frequency of the tests and the individual analytical determinations should depend upon the size of the plant, the kind of raw water treated and the type of system employed. It is difficult to generalize as to the specific determination that should be carried on in routine practice for all water supplies. The following information, however, is essential for the intelligent control of all plants: Total alkalinity; turbidity; hydrogen-ion concentration; temperature (air and water); volume of water treated; amount of chemicals used.

It is of great importance also that the operator keep a diary of conditions relating to the operation. Such information, if conscientiously recorded, is frequently of much importance in the interpretation of results and assists materially in allocating the cause or causes of faulty control and poor operating results.

GENERAL CLEANLINESS OF THE PLANT

The efficiency of control of a water purification system and the interest of the operator may be judged largely by the general cleanliness of the ground about the property. Water is a food product and its purification should be subject to the same general sanitary requirements in preparing it for human consumption as for any other food.

Cost Accounting on Street Maintenance*

Method employed at Berkeley, Cal., shows when repaving becomes more economical than continuing repairing

By Colonel A. J. Eddy†

No successful manufacturer or contractor would think of running his business without having accurate information as to the cost of the article that he manufactures, or of the construction units that he builds. They both demand an accurate up to date accounting of every detail that sums up into operating expense. The inner workings of a successful corporation are largely dependent for daily progress and for intelligent expansion on minute calculations in the hands of cost accountants. There is no reason why this factor should be neglected in city administration or why some form of intel-

†City engineer and superintendent of streets, Berkeley, Calif.

*From "Pacific Municipalities," organ of League of California Municipalities.

ligible compilation of cost data should not be applied to any department of city government that spends the public's money.

In Berkeley, California, the Department of Public Works has developed a system of maintaining cost data that has led to concrete results, especially in regard to street maintenance. Up to January, 1926, it had not been possible to obtain accurate cost data because of our inadequate system of bookkeeping. At this time, J. P. Langan was employed to take charge of all bookkeeping and cost finding, and he has reorganized our system so that accurate costs are now being obtained.

It was formerly the practice to charge materials against the various functions, or against the class of work for private parties at the time those materials were requisitioned. This led to considerable error because it was impossible to prophesy, at the time a requisition was made out, just how the various materials were going to be expended on actual work.

At the end of the fiscal year, a Public Works Stock Account was inaugurated in the department, and all requisitions for new materials are charged against this account. When the materials are actually used, they are charged against the particular job or function of the department, so that now actual and intelligible cost data on all classes of work are being obtained.

The most important result of our method of keeping cost data on street maintenance in Berkeley has been to demonstrate clearly that the greater cost of maintaining oil macadam pavements makes it profitable for us to pave our streets as soon as possible with permanent hard-surface pavements.

We can show to the city council or to the city manager or to the public just what streets are most in need of hard surfacing, and how much ought to be done at any given time, and we can tell them, in the clearly understandable language of dollars and cents, why it ought to be done.

The figures we keep show immediately whether or not an excessive amount is being spent for maintenance of the oil-macadam surface. If it is excessive, then this street, having probably the most traffic should be replaced with hard-surface pavement.

For example, the tabulation below, contained in the department's recent annual report, shows a list of five streets characterized as arterial highways, which are built of oil-macadam, and which are inadequate for the traffic they carry.

ARTERIAL HIGHWAYS OF OIL-MACADAM WHICH ARE INADEQUATE FOR TRAFFIC

Street	From	To	Length in Miles	Cost for 2 years	Cost per mile per year
Spruce St.	Los Angeles	Rose	.388	$1,278.21	$1,635.00
The Alameda	Monterey	Solano	.227	593.44	1,307.00
Solano Ave.	Alameda	Tulare	.298	617.20	1,034.00
Euclid Ave.	Eunice	Regal Rd.	.740	791.10	535.00
Ashby Ave.	Adeline	San Pablo	.938	945.73	504.00
		(Hard Surface)			
University	Third	Grove	1.55	164.06	53.00

The last item in the tabulation shows the cost of maintaining a hard-surface pavement which is comparable in volume of traffic to the oil-macadam examples above it. Thus we were able to show that it costs thirty-one times as much to maintain the portion of Spruce street, the first on the list, as it does to maintain a typical hard-surface pavement: and also that this particular section of Spruce street cost five times as much as the average of oil macadam streets for the fiscal year. Obviously, Spruce street is the one that needs the hard surface first.

The above is an example of the cost accounting that is done by this office for street maintenance, and other activities are handled in like manner. For example, Berkeley is required by ordinance to install all lateral sewer connections; also a large amount of trench resurfacing is done as a matter of convenience to the public utilities. Our cost accounting system demonstrated very soon that the rates being charged for this work were entirely too low; appropriate rates are now being charged and the city during this fiscal year will save several thousand dollars because each function is made to carry its own expense.

Name of Street, Oxford, from Hearst to Rose; Class, Oil Macadam. Width in feet, 20; length in feet, 3,000; length in miles, .568; area in sq. feet, 60,000; area in sq. yards, 6,667.

Date	Work Done	Cost of Labor	Cost of Equipment	Cost of Material	Total Cost	Cost per Lin. Ft.	Cost per Lin. Mile	Cost per Sq. Ft.	Cost per Sq. Yd.
10/13/24	Patched	$39.91	$8.84	$75.32	$124.07	.....	.....	.....	.....
3/12/25	Patched	10.78	2.95	24.35	38.08	.....	.....	.....	.....
5/28/25	Patched	16.96	4.72	18.53	40.21	.....	.....	.....	.....
7/21/25	Patched	16.85	4.70	24.25	45.80	.....	.....	.....	.....
11/ 3/25	Planed & Patch	46.10	20.88	42.89	109.87	.....	.....	.....	.....
2/16/26	Patched	25.46	7.57	32.23	65.26	.....	.....	.....	.....
5/28/26	Patched	39.04	11.05	51.84	101.93	.....	.....	.....	.....
	Totals for Period July 1, 1924, to June 30, 1926	$195.10	$60.71	$269.41	$525.22	$.1750	$924.60	$.0087	$.078

Large Springs in the United States

A spring of the first magnitude, according to the classification adopted by the Geological Survey, is one that has an average discharge of at least 100 cubic feet a second, or 65 million gallons a day. Water Supply Paper No. 557, by O. E. Meinzer, states that there are about 65 springs in the United States which supply at least this amount of water, and that there are several springs or groups of springs in the country each of which produces enough water to supply New York City.

Of the 65 first-magnitude springs, 38 issue from volcanic rocks, 24 from limestone, and 3 from sandstone. Of the 38 springs in volcanic rocks, 16 are in Oregon, 15 in Idaho, and 7 in California; of the 24 limestone springs, 11 are in Florida, 7 Missouri, 4 in Texas, and 1 each in Alabama and Arkansas; the 3 sandstone springs are all in Montana. The volcanic rocks are chiefly basalt that was greatly jointed and broken at the time it solidified, but large springs also issue from obsidian and rhyolite and from fragmental volcanic material. Limestone is so readily worn away by percolating ground water that it may be full of crevices, caverns, and natural tunnels. In many limestone regions surface streams are virtually absent, and nearly the entire drainage system consists of natural tunnels that carry the water underground. Where these tunnels come to the surface they produce large springs. The sandstone springs and a few of the other large springs issue from great fissures produced by faulting.

As a rule the large springs yield water that is very clear, but a few of the limestone springs become muddy after heavy rains. In deep spring pools the clear water generally has a beautiful delicate blue hue, and hence the name "Blue Spring" is applied to several of the large springs. The water in some of the spring pools is so transparent that objects at the bottom are distinctly visible, and fish can be seen swimming about as if in mid-air. In the well-known Silver Spring, in Marion County, Florida, glass-bottom boats are used, and the view through the sun-lit waters of the deep spring basin, with its underwater vegetation and fish of many varieties, is described as truly fascinating.

The huge springs that issue from the black lava walls of the canyon of Snake River below Shoshone Falls, in Idaho, are very spectacular. In a 40-mile stretch of the canyon below the falls there are 11 springs of the first magnitude, the largest of which furnish about enough water to supply New York City, and altogether the springs that discharge into this canyon yield enough water to supply all the cities in the United States of more than 100,000 inhabitants with 120 gallons a day for each inhabitant. Unfortunately, however, not even one large city can avail itself of this abundance of spring water, which is as pure as any bottled water sold for general use. Many of the springs issue 100 to 200 feet above the river, and their clear waters, dashing over the black rocks of the canyon walls, produce cataracts of striking beauty. The Thousand Springs, which discharge 864 cubic feet a second, are now in part harnessed to produce power, but formerly they made a waterfall 2,000 feet long and 195 feet high. Snowbank Spring, which is a part of the Thousand Springs, dashed over the rough talus slope forming a cataract of pure white against a background of intense black. The Niagara Springs, which issue from the canyon wall 125 feet above the river level, also form a spectacular cataract.

Silver Spring, in Florida, has a maximum flow of 822 cubic feet a second and is believed to be the largest limestone spring in the United States. Blue Spring, in the same county, apparently ranks next among the limestone springs of the country.

The largest spring in Missouri is probably Big Spring, in Carter county, but Greer Spring and Meramec Spring are close competitors. The largest spring in Arkansas is Mammoth Spring, in Fulton county; the largest in Alabama is the Big Spring at Tuscumbia; the largest in Pennsylvania is believed to be Boiling Spring, in Cumberland county; and the largest in Indiana is believed to be Wilson Spring, near White Cloud. All these springs issue from limestone, but Boiling and Wilson Springs are not springs of the first magnitude.

The largest springs in Texas are the Comal Springs, near New Braunfels. Other springs of the first magnitude in Texas are Goodenough Springs, 12 miles southeast of Comstock; San Marcos Springs, at San Marcos; and San Felipe Springs, 2 miles northeast of Del Rio. The historic San Antonio Springs are nearly if not quite of this magnitude. These springs issue from limestone in a great fault zone that extends through a large part of the State.

The largest springs in California are those at the head of Fall River. Other springs of the first magnitude are Rising River Springs, Great Springs, Burney Creek Springs, and Crystal Lake Springs. All these springs issue from volcanic rock in the northeastern part of the State.

Oregon has numerous huge springs that issue from volcanic rock. One of the largest and best known is Opal Spring, which is situated in the canyon of Crooked River. The combined flow of the springs along Crooked River, as well as that of the springs along Metolius River, would be sufficient to supply New York City.

The largest spring in Montana is Giant Spring, near Great Falls. The other two first-magnitude springs in the State are the Warm Springs and the Big Springs, near Lewistown. All these springs are believed to issue from fissures in sandstone.

Other large springs mentioned in the report are North, South, and Berrendo Springs, near Roswell, New Mexico, which were formerly springs of the first magnitude or nearly of that size, but are now dry or nearly dry as a result of the extensive use of artesian wells in that vicinity.

Air Compressor for Street Ice

In keeping its streets open in the winter time, Albany, New York, finds one of its greatest difficulties in the removing of ice which accumulates on the

street. Mr. Herzog, commissioner of public works, states that they have tried every known machine that has been manufactured and now uses an air compressor with four light spades, with which they break up the ice.

Winter Construction of a Concrete Bridge

By F. H. A. Nye

What was formerly known as State Highway No. 29, in La Crosse county, Wis., has been included in United States Highway No. 16, which traverses the entire state. That part of the highway lying in La Crosse county has been fully improved with an 18-foot roadway, part of which is of tar bound macadam and part of asphalt bound macadam, all in excellent condition. However, several bridges along this route have not been brought to the necessary width to accommodate the increasing traffic. One of these was located a short distance west of West Salem. This old bridge was a one-span steel truss bridge 18 feet wide and 110 feet long, with a rather steep approach at each end.

In December, 1926, the State Highway Commission contracted with E. J. Friederick & Chernus Co., of Indianapolis, for a deck girder type of reinforced concrete bridge 24 feet wide and consisting of three spans of 45 feet each; this bridge to be located 7 feet higher than the old bridge, or 30 feet above the creek level in order to eliminate the steep approaches. This is the maximum size of bridge of this particular type which is used by the State Highway Commission. The stream over which the bridge is built is insignificant in flow ordinarily, but drains a considerable area and becomes quite a torrent after heavy rainfalls. Quicksand exists at some depth at the site of the bridge and it was necessary to use 30-foot piles under the abutments and piers.

As the contract called for the completion of the bridge by April 15th, 1927, work was commenced on January 15th, necessitating the use of precautions to prevent the freezing of the concrete during the earlier part of the construction.

As the ground was frozen quite deep when construction began, about half a ton of dynamite was used to blow up the old bridge abutments and open up the earth for the new foundations. The frozen condition of the soil also made it impossible to construct a cofferdam of earth which would keep the water of the creek from the foundation excavation, and resort was had to two large pumps driven by electric power obtained from a line which followed the highway.

FINISHED ABUTMENT AND FORM FOR PIER HOUSED FOR PROTECTION AGAINST FREEZING

As it was still cold weather when the concrete was poured for the abutments and piers, the temperature at times reaching 20 below zero, precautions were taken to protect the concrete while setting. After constructing the form for each of these structures, a house was built over it and steam pipes laid inside the house so as to raise the temperature of the air. The sand and gravel aggregates were placed over a network of steam pipes and heated to about 70 degrees, as was also the water, before being used in the concrete. All of the concrete for any one abutment or pier was poured continuously so as to make the structure monolithic. A three-bag Koehring concrete mixer was used. When the concrete had set sufficiently to permit of smoothing the surface, the housing was removed and the cement was rubbed down to a smooth surface.

Raising the bridge 7 feet higher than the original one necessitated considerable filling in of the approaches and it was therefore thought advisable to pave these approaches with reinforced concrete.

The photographs show the great improvement

THE OLD BRIDGE WHICH HAS BEEN REPLACED

THE NEW BRIDGE VIEWED FROM THE SAME POINT

VIEW OF COMPLETED BRIDGE

not only in appearance but also in the usefulness and safety of the new, wide bridge as compared with the old, narrow truss bridge.

Stresses in Buried Pipe Lines

During the past two or three years bronze-welding of cast iron pipes has been introduced as a method of producing leak-proof joints in gas mains. In an effort to ascertain the cause of certain breaks in such lines, all of which occurred in winter, the U. S. Cast Iron Pipe & Foundry Co. and the Linde Air Products Co. conducted an investigation.

The test line was 1604 feet long, of 6-in. class 150 plain end de Lavoud cast iron pipe with bronze-welded joints, with expansion movement in long and short sections. At the ends of every section and at the center and quarter points of certain sections, pits were constructed so that measurements of ground and pipe temperature, movement of the pipe and strains induced in the line could be made at any time and under any weather conditions. Steam and water connections permitted making accelerated tests of temperature change.

The results of this study, as summarized in "Oxy-Acetylene Tips," are quoted below. The engineering data are so fundamental in character that they will be of interest to water works men and all others who have to deal with buried pipe lines. Incidentally, it may be said that it was concluded that the breaks which stimulated the investigation were due chiefly to failure to lay the pipe in a perfectly straight line and pack the backfilling solidly under and around it.

"Theory, checked by actual measurement, shows that the expansion and contraction of a buried line held under constraint by the friction of the backfill varies with the square of the temperature change. For the 6-in. cast iron line, the expansion in temperature was found to be only 0.005 in., while that for a 20-deg. increase was 0.020 in., or four times as great.

"In short sections of pipe, 100 ft. or less, the maximum temperature stress never exceeds 4,000 lb. per sq. in., no matter how large the temperature change may be. A maximum stress of 3,000 to 4,000 lb. per sq. in. is well within the safe strength of the material, but about as high as is permissible with safety for a cast iron pipe line where other superimposed strains from shock and bending are unknown. Accordingly, expansion joints should be spaced approximately every 100 ft., or every 8 to 10 lengths.

"This 100-ft. spacing of expansion joints has numerous practical advantages besides reducing the temperature stresses. It permits construction of sections that are conveniently handled and lowered in the trench, and facilitates aligning both for welding and straightening in the trench. If welded double lengths are shipped from the manufacturer or welded at some convenient point, only three field welds are required to lay about 100 feet of pipe."

Commenting editorially upon this test, "Oxy-Acetylene Tips" says:

"For the first time, definite figures are now available on the actual movement of buried lines with change in temperature. This foreshadows a more rational conception of the problems of expansion and contraction in lines of all types.

"A moment's consideration will show that the problems of expansion and contraction in buried lines are quite different from those in exposed lines.

For example, when a string of pipe lying on skids over the trench is subjected to a change in temperature, it simply expands or contracts, the amount of the movement being directly proportional to the temperature change. If the pipe is perfectly free to move there will be no stress in the pipe when it has acquired the new temperature.

"Now bury this same string of pipe with the ends extending out into pits so that the end movement is possible. Under the impetus of a temperature change, the pipe will tend to alter its length just as it did before, but it is no longer perfectly free to move. The earth packed around it offers resistance to such movement. The force required to move a unit section increases the further the unit is from the free end. It can readily be seen that at some point back from each free end, the force set up by the temperature change will not be sufficient to overcome the ground friction and there will be no movement. Consequently, if the buried section is of sufficient length, a certain portion at either end will move, but the central portion will remain motionless. Temperature stress will be maximum in this central portion, for there the stress is entirely unrelieved.

"Formulas developed from this line of reasoning were found to check very closely with actual measurements and the experimental results are of unusual interest. It is particularly interesting to note the relatively short section of line that is set in motion by even a large temperature change. Thus, a temperature change of even 80 deg. F. imparts motion only about 100 ft. back from each free end, no matter how long the section may be.

"All the data were obtained, of course, on a 6-in. cast iron line where ground friction was 500 lb. per sq. in., and direct comparisons with other lines are difficult because of variation in ground resistance. But, as pointed out above, here are definite figures that indicate at least the general magnitude of the changes involved, and as such should be of extreme interest to all pipe line men."

Garbage Collection De Luxe

In describing, before the International Association of Street Sanitation Officials, the system of garbage collection in Boston, Mass., Edward F. Murphy said: "One of our richest suburbs sends around a white truck, immaculate, painted right up to the minute, with four men, two on each side. The men have galvanized iron buckets, go into the garbage sheds, remove the garbage and place it in this beautifully painted truck covered with a tarpaulin or canvas which is washed every day. It is really giving a little tone to the collection of garbage. I think we all lose sight of that fact."

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CONTENTS

State Sanitary Engineers

Forty or more of our states employ sanitary engineers, who, working under the general direction of the State health officers, control the engineering activities of the states' disease prevention work, and, through their approval or disapproval of plans for water and sewage works, determine very largely the policies of the various states in regard to water purification, sewage treatment, and stream pollution. Malaria and mosquito control, flood sanitation, rural health work, and, of late, supervision of milk supplies are other duties they are called upon to undertake.

To fulfill properly these duties requires a considerable degree of engineering skill and training over a rather wide field, and, in addition, a strong personality. Yet it is doubtful if the average salary of these engineers exceeds $3,600 per year. This inadequacy of pay is reflected in a high turnover, and by the comparatively large number of very young men filling these positions.

A basic difficulty in remedying this situation lies in the fact that few states recognize the magnificent constructive possibilities that are attainable when an engineer of vision and ability is given a fair degree of freedom of action. An inexperienced engineer may carry along the routine of the office; a hand-to-mouth treatment of problems may suffice for a time; but a real program of improvements (such, for instance, as the water supply work being carried on by North Carolina) requires a trained and able head, an efficient organization, a free hand, and uninterrupted tenure of office; and no state should expect to secure these without adequate pay.

Unfortunately, it appears to be difficult for the average community, whether a town, a city, or a state, to evaluate accurately the services of its employees. If engineers would give more thought to the matter of informing all the citizens, in language which the "man in the street" can both understand and find interesting, of the work which they are doing and the results they aim at, getting the endorsement of civic societies, boards of trade and other voters, they might hasten the day of adequate salaries and more effective health service.

Reports by Municipal Departments

We make a practice of looking carefully through all reports of municipal departments which reach this office, with a view to discovering therein facts that may be of interest to the readers of *Public Works;* and many items that we publish are obtained in this way. Officials will help us increase the usefulness of this paper to other officials by sending us all their annual reports promptly on publication, and we urge them to do so.

Probably not half of the reports received contain information that would furnish the basis of what we think would be an interesting article. In most cases this is because the department has nothing but ordinary routine operation to report. But in some reports we find only bald lists of items of expenditures, with perhaps a list of hydrants installed, lengths of sewer laid, etc. Such a report might be useful to an auditing committee, but we fail to see how it can interest the citizens, and it certainly contains nothing of interest to outsiders. Other reports are not distributed until twelve to eighteen months after the close of the year to which they refer, during which time much water has passed under the tax payers' bridge and most of the information given is of little interest except to historians.

Too many officials, we fear, look upon the annual report as an irksome duty imposed upon them and to be gotten out of the way with a minimum of thought, time and interference with their "more important" duties. Instead, it should be welcomed by the official as an opportunity to explain to the citizens how he has been conducting the affairs of his office.

Officials are apt to complain that they never receive from citizens anything but criticism. How can they expect the encouragement and sympathy of tax payers who know how heavy their taxes are but nothing definite concerning what is done with the money? If, instead of a perfunctory list of lineal feet and cubic yards of work done, which mean little to the average citizen, the facts were set forth in narrative form, with emphasis on the more important points and a brief summary of the routine and less interesting figures, we believe the officials would be richly rewarded by the interest and sympathy of the citizens: who, after all, are paying for the work and are entitled to all the information concerning it that they can appreciate.

We urge city officials to give more thought to their annual reports, because both of the obligation they owe the taxpayers and also the benefit they themselves will almost certainly receive therefrom.

One other criticism we have to offer. A few reports reach this office in which we can find no mention of the municipality to which they apply. A report reached us the other day published by the "Board of Water Commissions," city not named. We find in it, in small type, one reference to the "Water Commissioners of the City of F—"; but there are cities of that name in thirty-two states and we find nothing in the report to tell which of these states this particular F— is in. There is good reason for the common practice of placing the name of the city and state on the front cover of every report or other document published by a city department.

Storm Sewer Design in England

About thirty-five years ago Emil Kuichling, of Rochester, N. Y., developed a method of estimating the run-off from city areas to storm sewers in which perviousness of surface, time of concentration to and through the sewers, and maximum rates of rainfall for each time of concentration, were considered. This "rational" method was described at some length in 1898 in the first edition of Folwell's "Sewerage" and since then it has been quite generally adopted in this country and several refinements have been devised and described in papers before engineering societies.

On March 26th of this year, in a paper before the Institution of Municipal and County Engineers, England, a paper was read describing a variation of this called by the author the analytical method, from which it appears that the idea is new in England, having been presented in two papers before the Institution of Civil Engineers within the last five years or so and as yet put into use by very few engineers.

The general practice there seems to be to use a fixed amount of run-off in inches per hour, disregarding any effect of perviousness of soil, size and shape of drained area, local rainfall rates, etc. This was the practice in this country fifty years ago, when one inch was commonly used. Sewers designed on such a basis in Brooklyn, N. Y., began shortly after that date, to develop disastrous results of incapacity as the city built up and impervious pavements replaced dirt and cobble stones, and millions have been spent in constructing relief sewers to carry perhaps three times the run-off for which the original sewers were designed.

It is interesting to learn from the discussion of this English paper that the Ministry accepted storm sewer designs on the basis of one-eighth of an inch per hour until just before the war, when it increased this to one-quarter inch; and that some engineers, desiring to be on the safe side, have been using one-third of an inch for built-up and paved areas—one fifth to one-tenth of American practice. Some figures given indicate that rainfall rates of about 1½ inches for a 5 minute period, 0.57 inch for 30 minutes and 1-3 inch for 60 minutes are considered safe maximums for English practice. Also 33 to 40 per cent is recommended as an impermeability factor in developed residential areas.

From which it would appear that, much as American engineers can learn concerning sewage treatment from English practice, in the matter of storm sewer design they should rely upon rainfall records and methods of design of United States origin.

Public Works for Slack Times

The officials of the city of Los Angeles, California, in 1925 took under advisement the recommendation of Secretary Hoover and others that, when there is a slackening of demand for labor and materials in private industry, public improvement work should be brought forward in order to keep labor employed and money in circulation, another advantage of this being that the work probably could be obtained at less cost than at other times. In his report for 1926, George E. Cryer, mayor of Los Angeles, states that "we have made every effort to speed up public improvements and have succeeded in accomplishing a volume of work far greater than ever before in a similar period in the history of the city. As a result, surplus labor has been given employment, money has been kept in circulation and Los Angeles has scarcely realized that she has been passing through a period of comparative quiet in the business, and industrial world."

"Some idea of the volume of work being accomplished may be gathered from the fact that during the twelve months ending December 31, 1926, a greater mileage of street improvements was installed than during the entire six-year period from 1917 to 1923. In addition to this, a great system of storm sewers is being installed, a series of fine viaducts across the Los Angeles river are being constructed, and many miles of ornamental street lights are being completed."

Figures for miles of street and alleys paved during the three years, 1924, 1925 and 1926 show that this mileage increased from 87.33 in the first year to 156.39 during the second and to 174.25 in 1926. The total cost of the improvements similarly increased from $9,417,014 in 1924 to $17,644,800 in 1925 and $21,103,191 in 1926.

Conference of State Sanitary Engineers

Abstract of papers and reports presented to the June conference, dealing with swimming pools, milk and shellfish sanitation, hand pumps and wells, sewage treatment, and camp sanitation.

Following are abstracts of some of the papers and committee reports presented at the Eighth Annual Conference of State Sanitary Engineers, which was held at Chicago June 4-6. An account of the business of the meeting is reported in our society news columns on another page.

SWIMMING POOLS AND BATHING BEACHES

Final report of this committee, Stephen DeM. Gage, chairman, followed along the lines of previous reports which were presented to both the Conference of State Sanitary Engineers and the Public Health Engineering Section of the A. P. H. A., with only minor revisions. Complete standards were given for the design, equipment and operation of swimming pools and bathing places, which are classified as (a) Natural outdoor ponds, rivers, and tidal waters; (b) Outdoor pools partly natural and partly artificial; (c) Pools, outdoor or indoor, entirely of artificial construction. Classes (b) and (c) are further sub-divided according to the method of replacement or purification of water. A rate not greater than 3 m.g.d. per acre for slow sand filters and 3 gallons per square foot per minute for rapid filters are fixed as the maximum. For average bathing loads, the filters should be able to filter the entire pool contents twice daily, and with heavy loads, three times daily. Chlorination is considered the most satisfactory method of disinfection, and application as a gas or a water solution is preferred. A residual or excess chlorine of 0.2 to 0.5 p.p.m. should be maintained at all times. The 24-hour bacterial count at 37°C on agar or litmus bactose agar should not show more than 10 per cent of the samples with more than 100 bacteria per c.c., and no single sample should show over 200 per c.c., and not more than 2 out of 5 samples collected on the same day, or 3 out of any 10 consecutive samples, should show a positive presumptive test. The bathing load is limited to 20 persons for each thousand gallons of clean water added to the pool.

ELECTROPURE PROCESS OF MILK SANITATION

R. E. Irwin, assistant sanitary engineer of the Pennsylvania Department of Health, described at some length tests made regarding the possibility of treating milk by the Electropure process, which, through electric heat at a comparatively high temperature—160 to 165° F—and a short holding period, lessens materially the time now required for pasteurization, and makes control of the process easier. Temperatures under 165° F did not produce satisfactory results, but at that temperature the bacterial reduction was fairly satisfactory, and some advantages over the present pasteurization process appeared to accrue.

PUMPS AND WELLS

Although H. F. Ferguson was absent, the report of his committee was presented. It referred mainly to small or hand-pump wells and pumps suitable for them. Fifty feet was recommended as being the minimum safe distance (100 feet is considered desirable) from fixed sources of pollution. In coarse gravel, limestone, and disintegrated rock sections a greater distance and special construction are necessary. The well-top, in all cases, should be one foot above the ground level to avoid surface contamination, and should be constructed of permanent materials. In dug and bored wells, watertight construction is required for a depth of at least 6 feet. Hand pumps should have a solid one-piece recessed base, cast integral with or threaded to the pump-stand or column.

Most pumps now on the market were criticised as allowing contamination of the piston rod by hand, birds, and flies, though this factor was recognized to be one of minor consideration.

SEWAGE TREATMENT

Particular emphasis is placed, in the progress report of the Committee on Sewage Treatment, of which F. H. Waring is chairman, on the operation and control of sewage treatment works. Legal regulations governing the installation and operation of works for sewage treatment, the attitude of municipalities toward efforts to procure scientific operation of such works, and policies determined upon by state administrative authorities regarding the disposal of sewage were discussed, and experiences and observations in the operation of existing works related. It was recommended that authority be given a central agency, preferably the state board or department of health, to require the installation of works for the proper disposal of sewage. Stream pollution should also be subject to order where the public health is involved.

Operation of a sewage disposal plant is the deciding factor in determining whether the plant is a success or a failure. Provision for operation involves two main considerations, personnel and finance, which are closely related. It is very difficult to convince small cities of the value and necessity of skilled and competent operators, but without such operation the plant fails. Mr. Waring suggested as a remedy, special effort on the part of the state health officials toward the education of city officials in this regard, and also the possibility of arranging for such operation at the time the plant permit is granted.

CAMP AND OUTDOOR SANITATION

The committee recommended that responsibility for tourist camp sanitation should rest with the local health agency. In regard to roadside water supplies, some doubt was expressed of the importance of this work. Unless these supplies are checked regularly, the results are of little value except from the publicity viewpoint, while if properly

done, there is a large cost in time and money. There was considerable discussion over a standard type of sign, but no standard practice was settled on.

SHELLFISH SANITATION

Questionnaires to officials of states producing shellfish elicited replies from all but two, both of which represent but a small portion of the industry. Sanitary surveys of shellfish areas have been employed in all the states in helping to rule out contaminated areas. Only 5 of 16 states reported using floats in tracing sewage pollution, and 2 of these states questioned their value. Four states report detailed investigations of the effect of varying winds and currents. Only 2 states have computed tidal prisms, and these give no information of interest. No state reports dependence upon continuous sewage treatment for shellfish protection, except in the case of one small fairly well-removed outlet.

Methods of sampling waters appear widely divergent. A few states collect samples along cross-section lines; others collect scattered samples. Opened areas are re-sampled at intervals varying from one month to one year. Some states collect both bottom and top water samples; others only top samples, and still others only bottom samples. Nine states report a close correlation between top and bottom water samples, though one of these reports considerable variation in badly contaminated sections. Seven states make bacterial counts on water samples, 8 do not, and 1 sometimes does. All states follow the A. P. H. A. standard in examining shellfish, with one variation. There was considerable variety regarding the correlation between water and shellfish analyses and no definite practice was established.

Water Waste Survey at Springfield, Ohio

Water waste surveys were made in Springfield, Ohio in 1919 and in 1923 with gratifying results, and when during 1924 and the first half of 1925 there was an unexplained increase in the pumpage, it was decided to have another survey to locate, if possible, the cause of it. The same company which had made the 1919 and 1923 surveys, The Pitometer Company, was engaged for this work.

Tests were made first at the pumping station to determine if there was any slip in the pumps. There were three pumps ranging in age from 31 years to 13 years. In none of these was a slip found exceeding 5%.

Following this, the average daily consumption of the city and the variations during the 24 hours were measured for several days. The city was then divided in districts to determine the total consumption in each, and each district was subdivided during the night time to ascertain the rate of flow in individual blocks. Those blocks showing high rates of flow were further investigated to locate the exact point of waste or leakage.

Seventy-two leaks were found, 20 of these being joints in mains, 36 in service pipes and 16 miscellaneous. The total reduction of daily consumption effected by discovering and eliminating leaks was approximately 20% of the total consumption or over two million gallons. The largest leak located was a defective lead joint in a 10-inch line where it passed under a creek. This was discharging 250,000 gallons a day into the creek, and all the other leaks had been finding outlets through sewers without surface indication.

Following the reduction in leakage, it was found possible to reduce the pressure at the pumping station from 90 pounds to 80 pounds with no noticeable affect on the pressure in the city, which is three miles away. As a similar survey had been made in 1923 when nearly two and a half million gallons per day of underground leakage had been located and stopped, the water works officials believe that periodic investigations of this kind are of great value.

Sewage Sludge as Fertilizer

At the request of a subscriber we have prepared a list of leading articles on this subject which have appeared in periodic literature during the past few years. Thinking it may be of interest to others also, we present it herewith.

Schenectady Markets Sewage. "Health News," N. Y. State Department of Health, Albany, Vol. 3, No. 22, May 31, 1926. p. 86. Also "Public Works," October, 1926, p. 348.

Sewage Sludge. "American Journal of Public Health," Vol. 16, No. 1, Jan. 1926, pp. 39-42.

Heat Drying of Sludge at the Baltimore Sewage Works. C. E. Keefer, "Engineering News-Record," Vol. 96, No. 6, Feb. 11, 1926, pp. 238-240.

Utilization of Sewage Sludge. Report of Committee of American Public Health Association and American Society for Municipal Improvements. "Public Works," December, 1925, p. 441.

Activated Sludge Conserves City Wastes for Fertilizer. "Wis. State Bulletin" 362, 1924, pp. 17-19; Exp. Sta. Record, U. S. Department of Agriculture, Oct. 1924, p. 423.

Sludge Disposal in the Surbiton, Surrey (England) Urban Dist. C. A. Snooks, Sewage Works Mgr., "Surveyor," Vol. 66, No. 1713, Nov. 14, 1924, pp. 399-400 .

Fertilizing Value of Activated Sludge, Report on Milwaukee Work. "Public Works," Vol. 55, No. 1, January, 1924, pp. 23-24.

Hygienic Aspects of Use of Sewage Sludge as Fertilizer. Abel Wolman, "Engineering News-Record," Vol. 92, No. 5, Jan. 31, 1924, pp. 198-202.

Investigation on the Fertilizing Value of Activated Sludge. Victor H. Kadish, Milwaukee Sewerage Commission. "The International Conference of Sanitary Engineering." London, 1924, pp. 134-8.

Fertilizers from Sewage Sludge. J. S. Alford, "Surveyor," Vol. 66, No. 1712, Nov. 7, 1924. p. 338.

Activated Sludge as a Fertilizer. Victor H. Kadish and O. J. Noers, "Public Works," October, 1924. p. 311. Also "Engineering and Contracting," Oct. 8, 1924. pp. 817-820.

Sewage Sludge Problem in the U. S. Report of Committee on Sludge, A. P. H. A. "Waterworks," Vol. 60, No. 5, Nov. 14, 1923, pp. 1020-2.

Economics of Activated Sludge Process. C. Lee Peck. "Engineering News-Record," Vol. 90, No. 12, March 22, 1923, pp. 522-26.

Characteristics of Some Connecticut Sludges. J. J. Jackson, and Joseph Doman, Comn. St. Dept. of Health. "Engineering and Contracting," Vol. 57, No. 2, Jan. 11, 1922, pp. 35-39.

The Fertilizer Value of Activated Sludge, Irving P. Kane, The Sanitary District of Chicago, "Proceedings, American Society for Municipal Improvements," 1922, pp. 113-127.

Utilization of Sewage Sludge. John D. Watson, "Journal, Royal Sanitary Institute," Vol. 42, No. 2, Sept. 1921, pp. 90-6.

Report on Fertilizing Value of Activated Sludge. H. D. Brown, Bulletin No. 10, Bureau of San. Engrg., Bd. of Health, Ontario, Canada. Annual Report, 1921, pp. 115-126. Also report for 1920, pp. 131-155.

American Water Works Convention

Abstracts of papers read before the June convention, dealing with quality and purification, plant construction and operation, administration, etc.

Below are given brief abstracts of a number of the papers presented at the 1927 meeting of the American Water Works Association, which was held at Chicago, June 6-11. A report of the business sessions is given on another page.

After the business session Tuesday morning, W. D. Collins, chemist in charge, Quality of Water Division, U. S. Geological Survey, presented a paper on "Quality of Water and Industrial Development." For certain types of industries, such as iron and steel mills, quality of water is almost a negligible factor and location is determined by other economic causes; in other industries, as the manufacturer of wool and silk goods, the quality of water largely determines the location. The availability of water power (or electric power derived from water) is important; if steam power must be used, water quality is of great importance. About 25 years ago, the U. S. Geological Survey began systematic studies of the chemical character of natural waters with reference to their industrial use. Data of this sort are of great value to companies considering locations for new plants. To be good industrially, water must not only be pure, but soft, also.

At the afternoon session, Dana Pierce told in detail of the Underwriters' Laboratory and Waterworks Equipment and the service available through this. H. H. Hyman, who was scheduled for a paper describing the restoration of the Miami water service following the hurricane, was not present, but sent a short paper, which was read. Full water service was available within 48 hours, most of the trouble being caused by the cutting off of the electric current.

John S. Dean, of the Chicago Bureau of Engineering, described the Chicago Avenue tunnel construction methods. In the construction of the new intake, electric power was preferred over steam and oil, motor driven Ingersoll Rand air compressors being used. A 16-foot shaft is being constructed from the new intake to the 2-mile crib, the bench method of driving the tunnel being used. Both hand and machine mucking have been employed.

A. E. Gorman described at some length the method of chlorination control in Chicago. No other treatment than chlorination is applied. There has been a resultant steady decrease in typhoid (this decrease is undoubtedly due in part to milk pasteurization and hospitalization of typhoid). Every chlorinating unit is in duplicate and provision has been made for dosage up to 7 pounds per million gallons in case of emergency. There are 35 M S V type, Wallace and Tiernan chlorinators in use, and 12 more have been ordered. About 1 1-3 million pounds of chlorine per year are used. The cost is about 5 cents per person per year. Very careful checking of the dosage is maintained, and an effort made to have residual chlorine always present in the amount of about 1 pound per million gallons. This paper was discussed by W. W. Brush and N. J. Howard.

A paper by Wynkoop Kiersted describing the Amarillo. Tex., plant was read. Formerly served by 37 wells, 300 feet or more deep, the cost was high, due to wide distribution of wells, high lift, and small yield, which was insufficient for the rapidly growing town. A new dam and reservoir was constructed to reinforce the well supply, giving a total yield of 10 million gallons daily. The total cost was $2,100,000.

J. B. Eddy, chief of the pipe extension bureau of the Chicago Department of Public Works, in an address illustrated by lantern slides opened the Wednesday sessions with a description of Chicago's distribution system, tracing the growth of the system from 1837 to the present time. Of especial interest was the outline of the studies being made on future consumption and the flow in the present mains. The city is studied by sections (640 acres each), and from the analytical survey of these the character of the population is determined and its future growth and water demand estimated for 5-year periods in the future. Much time was devoted to an interesting discussion in regard to leakage, which averages 13,000 gallons per mile of mains. Leakage surveys have been pushed, and the development of a new method of discovering leaks by means of fuchsin dye has proven very valuable in areas where the use of sounding devices was not possible because of high ground water.

"Public Relations" was the subject of a paper by Daniel T. Pierce, which was read by C. A. Emerson, Jr. Mr. Pierce stressed the fact that public confidence must be based on honesty, and that publicity campaigns are foredoomed to failure unless they have a sound basis of facts. Cecil F. Elmes, in a long paper on "Legal Decisions Affecting the Financing of Water Utilities," reviewed the present day trend of policies and decisions affecting finances and returns. Mr. Elmes discussed also reproduction cost, forecasting future prices, rate of return, and measure of depreciation. In summarizing, he called attention to the fact that courts, as a rule, hold definitely that present reproduction cost is the best indication of present value, and that "going value," water rights, etc., have a definite dollars and cents value. An adequate rate of return is recognized as necessary, for the stockholder as well as the creditor.

F. B. Leopold, of Pittsburgh, describing the duplex concrete filter manifold system developed by him, stated that, while the general features of a modern mechanical filter plant essential to efficient operation are now fairly well established, there still remains room for improvement in certain details of design, among which one of the most important is the manifold system for distributing the wash water and collecting the filtered water.

Most designers still use the central manifold with lateral pipes, maintaining the original design as a basis, the principal departure being the elimination of strainers originally used, and the use of cast iron not only for the manifold, but also for the laterals.

This is so far the most satisfactory arrangement of manifold systems though there have been a number of plants built with false bottoms, with strainers spaced to correspond to openings in the lateral systems.

None of these has obviated the necessity of frequent rebuilding of the beds, and it is the writer's experience that the beds of the average filter plant must be rebuilt once every four or five years. This would not be necessary if there were no disturbance of the fine gravel, which is the final support of the sand bed.

The duplex filter bottom developed by the writer consists of a double system of distribution. The primary system corresponds to the ordinary manifold header and laterals and uses the same relative area of nozzle openings. It consists of a concrete conduit, with the laterals facing it on either side. In the openings in the laterals are set heavy glass nipples, which form the distributing orifices. On top of this system is placed a secondary system composed of interlocking hollow blocks, closed on one end, each about 2 feet long and 1 foot wide, and forming, therefore, an individual section of 2 square feet for each block. The top surface is corrugated and perforated with openings 1¼ inches on centers. The area of these openings is such as to reduce the velocity of the water of the primary system to about one-fifth. This gives better diffusion, and the blocks prevent the rush of water to an area of less resistance.

A very thin gravel bed is used (about 3 inches) and the particles are ⅛ inch to 5-16 inch. Even with a rise of 30 inches there was no apparent movement of the gravel.

In addition to the better distribution of wash water, which should prevent the necessity of frequent rebuilding of the bed, there is the additional advantage in this type of construction that all metal is eliminated, and corrosion avoided.

W. W. Brush, at the afternoon session, reported on the compensation of executive and technical forces employed in waterworks and other utilities. The salaries reported ranged from $2,000 to $12,000, with an average for cities under $200,000 of around $4,000. Upon motion by Mr. Brush, the convention authorized the president to appoint a committee to consider the formulation of a minimum salary schedule.

The new waterworks plant at Spartansburg, S. C., was described by H. F. Wiedeman, D. C. Grobbel read a paper on the application of machines in water works accounting; which had special reference to conditions in Detroit.

(To be continued)

Classifying Brick by Sound

The May issue of the Journal of the Franklin Institute contains an article by Juichi Obata, of the Physics Division of the Tokio Imperial University, describing experiments made by him with a view to discriminating the quality of brick by means of the sound given off by said brick when struck. To produce the sound, a brick was supported by the hand and struck at the middle part with a small steel hammer. These bricks were then tested and the modulus E (obtained from a compression test), divided by the density, was then compared with the pitch of the sound. The relation between the pitch and the compressive strength of the brick was found to be: compressive strength in pounds per square inch equals 100 times the pitch divided by 35, minus 1,500. A record of the sounds was obtained by using a condenser microphone, the record being obtained with an oscillograph.

In determining the pitch it was found that a tuning fork is not suitable because its tone color is so different from that of brick, and a civil engineer, S. Kanamori, found that the tone of a xylophone was most suitable for the purpose. Apparently nothing was determined as to the effect on the sound of differences of materials from which or processes by which the bricks were made, or of dimensions.

Road Location on South Slopes

Part of the "Rim-of-the-World" drive, in San Bernardino County, California, rises to an altitude of more than 6,000 feet, Section "B" meandering along the crest of a ridge. At some points the road was located on the north slope, and here snow, sheltered from the sun, last much longer than on the south slope. The left side of the picture shows one of these north slope sections on April 15th of this year. This section is being reconstructed, and relocations made, avoiding the north slopes. The advantage of this is shown by the right hand picture of a south slope location taken at the same time as the other. Snow-clad mountains are seen in the distance. A wide space for parking is seen on the right of the new road.

SNOW ON OLD ROAD APRIL 15th

SNOW-FREE ROAD ON NEW SOUTH SLOPE LOCATION

Recent Legal Decisions

ELIMINATION OF PART OF WORK AFTER RECEIPT OF BIDS

Where an advertisement for paving bids reserved the right to the city to reject any or all bids or parts of bids, the Pennsylvania Supreme Court held, Straw v. City of Williamsport, 286 Pa. 41, 132 Atl. 804, that when the bidders placed their unit prices opposite the work to be done, they knew that, as a part of the proposal, the city might reject any part of any bid, provided, of course, the part rejected applied to all bidders. The standard for competition was then the same for all persons desiring to compete for the work. If the city, after tabulation, designated one of the parties as the lowest bidder to whom the contract must be awarded, by that act it accepted his proposition, and the subsequent rejection of any part of the proposed work would not be a rejection of any part of the bid, but of the work.

After the bids were received for a paving improvement, the city council, because of lack of funds to complete the entire improvement, eliminated all the items relating to sewers not necessary to the work, the effect being to place another as lowest bidder than the lowest bidder for the entire work. It was held that the city had the discretionary power to abandon such sewer work as it deemed necessary to the general plan, and the trial court's finding that it had not abused its discretion was binding on appeal.

LIABILITY FOR EXTRA CONCRETE WORK REQUIRED AS FOUNDATION OF STREET RAILWAY TRACKS

The Georgia Supreme Court holds, Clarke v. City of Atlanta, 136 S. E. 429, that where in paving a given street on which tracks of a street railroad company are located the city requires extra concrete work as a foundation in the portion of the street occupied by the street railway tracks, such extra concrete work must be regarded as a part of the pavement to be assessed against the street railway company.

STATE CONSTITUTION PROVISION PROHIBITING EXTRA COMPENSATION TO CONTRACTORS

A contractor undertook certain excavation work for a levee district; it encountered difficulties unknown and unsuspected by either party; it notified the district thereof at once, and of its intention to claim additional compensation; it was told by the district board to proceed with the work and that the matter of additional compensation would be adjusted on final completion; it completed the work and claimed additional compensation, which the district refused to pay. The Louisiana Supreme Court held, Picard Const. Co. v. Board of Comrs. of Caddo Levee Dist., 161 La. 1002, 109 So. 816, that the contractor was not entitled to recover additional compensation beyond the contract price, no misrepresentations or concealment as to the character of the work to be done being alleged. The legislature having no power, under the state constitution, to authorize the granting of extra compensation to contractors, public boards, which are mere state agencies, are without authority to make such grants. And the difficulty in performing a contract is held to be no excuse for not performing it.

SUBCONTRACTOR ON ROAD WORK HELD ENTITLED TO PROTECTION OF ROAD CONTRACTOR'S STATUTORY BOND

Before entering upon public work, a road contractor executed a bond with the usual obligation to perform the contract and the additional obligation that the principal "shall promptly pay all just claims * * * for labor and materials incurred by said principal in or about the construction or improvement contracted for." This was held sufficient, under section 3533, Florida Revised General Statutes 1920, to afford protection to persons supplying labor and materials in the prosecution of the work.

A subcontractor on public work who by himself or through other persons in his employ, or by the use of teams or mechanical equipment, has furnished labor in the prosecution of the work for a stated consideration agreed upon with the principal contractor, may recover that consideration in his status or capacity as such subcontractor from the surety upon a bond executed pursuant to and containing the additional obligation required by the statute. The protection of this section is not limited to those who "perform" labor or public work, but extends to those who "supply" labor. One may supply labor by providing others to do the work. Nor is it limited to "laborers"; that is, those who perform physical labor. Labor performed with the aid of horses, tractors and derricks, and other mechanical equipment or devices, is within the meaning of the statute, so long as such labor is supplied in the prosecution of the work.

WAIVER BY PUBLIC CONTRACTOR AND SUBCONTRACTOR OF TIME LIMITS

The Michigan Supreme Court holds, Realty Construction Co. v. Kennedy, 234 Mich. 490, 208 N. W. 455, that where the evidence in an action by a contractor for the erection of a public building against a subcontractor for failure to complete the work showed that the subcontractor, due to the fault of the contractor, did not commence work until six weeks after the time agreed, the question of waiver of time for completion was for the court, which held that the subcontractor by commencing when he did, waived the fact that he should have commenced at the date fixed, and the contractor waived the fact that the work was not completed on the date fixed.

RECOVERY BY CONTRACTOR'S LABORER FOR ATTORNEY'S FEE IN ACTION FOR DELAY IN PAYING WAGES.

Under Oregon Laws, section 6799, the only instance which a laborer cannot recover attorney's fee in an action to collect his wages not paid within 48 hours after demand is where he voluntarily quits without giving three days' notice. When the contractors abandon the job and their surety takes it over and completes it, the surety becomes subject to the contractor's liability for the fee.

PUBLIC WORKS CONTRACTOR HELD, UNDER CONTRACT, NOT EMPLOYER OF SUBCONTRACTOR'S EMPLOYEE

Contracts of employment by virtue of the Minnesota Workmen's Compensation Act, contain an implied provision that the employer, in case of injury, will pay the employee compensation. But before the commission can make an award, the relation of employer and employe must be estabshed. A portion of the work for a judicial ditch was sublet. One of the subcontractor's employes was accidentally killed in the course of his employment. His representatives sought to hold the subcontractor, the principal contractor and its insurance carrier liable under the act. It was held that the principal contractor was not the employer of the deceased. The subcontractor was an independent contractor, and not merely an agent of the principal contractor. The contractual requirement that the work should be done under the supervision of the engineer did not make him such an agent. What the general contractor expected and required was that the subcontractor do the work to suit the county for whom the engineer was acting. This was safer than to require it to be done to suit themselves. Erickson v. Kircher, Minnesota Supreme Court, 309 N. W. 644.

CONTRACTOR'S RIGHT TO RECOVER FOR REMOVAL OF HARDPAN NOT COVERED BY CONTRACT

A contract to grade and remove earth for road construction at 34 cents per cubic yard did not call for the removal of hardpan. The contractor came on hardpan which he removed under the oral direction of the county engineer, on the understanding that he should receive extra compensation therefor. It was held that this agreement being oral and not competitive bids, was, under Rem. Comp. Stat. §§ 6616, 6617, illegal as a contract; and that, the work being accepted by the county, the contractor was entitled to reasonable compensation therefor. Bresoloff v. Whatcom County, Washington Supreme Court, 248 Pac. 381.

GRADING CONTRACTOR HELD, UNDER CONTRACT, NOT LIABLE FOR FAILURE TO PROVIDE GUARD RAIL FOR EMBANKMENT

A grading contractor, constructing an embankment to form part of a state trunk highway, was held not liable for an accident caused by failure to erect a guard rail, under a contract binding him to provide barricades and lights. The job was finished and in use before the accident, but not accepted. The court said: "For negligent defects of construction, a public contractor may in some cases be liable to users of his work. But that liability is limited to defects in his own work. His negligence certainly cannot be predicated upon the omission of a distinct element which not only is not called for by his contract, but which is withheld for installation under another and subsequent one. That is this case." Rengstorf v. Winston Bros. Co., Minnesota Supreme Court, 208 N. W. 995.

EXTENT OF ROAD CONTRACTOR'S LIABILITY FOR PREMIUM TO WORKMEN'S COMPENSATION FUND

The North Dakota Supreme Court holds, State v. Padgett, 209 N. W. 388, in a suit by the state on behalf of the Workmen's Compensation Fund to recover the balance of a premium from a road contractor, that it is not a condition in the surety bond that a person who contracts with the State Highway Commission to construct roads shall pay the full premium found to be due the compensation fund, when the only stipulation in the agreement with the commission is that the contractor will comply with the Workmen's Compensation Law, and the evidence shows such compliance as fully protected the contractor's employes.

DREDGING COMPANY'S RIGHT TO RECOVER PROFITS UNDER CONTRACT WITH CONTRACTORS

Under a tripartite contract, whereby a dredging company agreed with the contractor and subcontractor for dredging work for a drainage district to furnish a dredging machine in consideration of a percentage of the profits after payment of operating expenses, the Mississippi Supreme Court held, Union Indemnity Co. v. Wineman, 108 So. 796, that recovery could not be had by the dredging company against the drainage district or the surety on the contractor's bond where it was not contended that the operating expenses had not been paid or that there were any net profits from the joint adventure.

RIGHTS OF ASSIGNOR AND ASSIGNEE OF CONSTRUCTION CONTRACT

The Texas Court of Civil Appeals holds, Southern Surety Co. v. Callahan Const. Co., 283 S. W. 1098, that a construction company which, with the consent of the water improvement district with which it has a contract, assigns the contract to another construction company, so that it becomes a contract between the assignee and the district, is only secondarily liable for the performance of the contract by the assignee. The assignee having agreed to perform all the conditions of the contract, which provided that the plans might be changed by the district's engineer, the assignee had no claim on the assignor based on a change in the plans made by the engineer.

STATUTORY PROCEDURE IN ACTION ON ROAD CONTRACTOR'S BOND MUST BE FOLLOWED

Mississippi Laws 1918, c. 217, provides a definite procedure to be followed in bringing action on a bond executed by a road contractor, and as the action is statutory, these requirements must be observed in all essential respects in order to recover thereunder. Failure to make publication in the county where the work was done as required by section 6 was held to be a fatal error, notwithstanding the failure was not pleaded in abatement nor called to the court's attention any other way, since section 4 requires there should be but one suit, and the necessary parties are to be brought in by such publication. United States Fidelity & Guaranty Co. v. Mobley, Mississippi Supreme Court, 108 So. 501.

MATERIALMAN'S RIGHT OF RECOVERY ON PUBLIC CONTRACTOR'S BOND

A planing mill company which had a contract directly with the contractor for a school building for material, and was not paid by the contract, was held entitled to recover on the contractor's bond, which provided that the contractor should pay all persons who had contracts directly with the principal for labor or materials. The company was entitled to interest on the amount due from the date it became due. National Surety Co. v. Daviess County Planing Mill Co., Kentucky Court of Appeals, 281 S. W. 791.

BUILDINGS IN PUBLIC PARKS

A city voted, on a proposition submitted to the electors, a large amount of bonds for the erection of a city hall and auditorium in a public park. These bonds were sold, and a tax levied by the city for their partial payment; after which a building on the proposed site was razed at considerable expense. Plans and specifications were procured and contracts let for the construction and completion of the building, and large expenditures were made for material therefor. Taxpayers, who had stood by while these things were being done, brought suit to enjoin the erection of the building in the park, on the ground that it was inconsistent with the purpose for which the park was procured and used. The Kansas Supreme Court held, Kirsch v. City of Abilene, 244 Pac, 1054, that although an action might have been maintained if timely brought, the plaintiffs' delay in asserting their rights was unreasonable under the circumstances, and constituted such laches as barred the relief they asked.

PROOF OF ABANDONMENT OF HIGHWAY

The Mississippi Supreme Court holds, Noxubee v. Long, 106 So. 83, that the abandonment of a road may be shown by the statement "Road Link No. 11 discontinued" on minutes of the board of supervisors of highways dealing with the appointment of road overseers.

MUNICIPAL WATERWORKS AND LIGHT PLANT HELD ONE PUBLIC UTILITY

The Louisiana Supreme Court holds, Gisclard, v. City of Donaldsonville, 106 So. 287, that a municipally operated waterworks and electric light plant must be deemed one public utility, so that it may be hypothecated under La. Const. 1927, art. 14, §14, par (m) and Act No. 80 of Ex. Sess. 1921, to secure bonds for the betterment of either the waterworks or the electric light and power service, or for both services indiscriminately.

CONTRIBUTORY NEGLIGENCE IN USE OF SIDEWALK IN DAYTIME

The Massachusetts Supreme Judicial Court holds, Cox v. City of Boston, 150 N. E. 301, that mere knowledge of a defective condition of a highway does not bar recovery by a traveler injured thereby in the daytime; but a traveler who, with ample space and full knowledge, daylight and alert attention, steps into a small hole in a large sidewalk free from other travel or diverting circumstances of any kind, has not exercised due care as matter of law.

The Georgia Supreme Court holds, City of Macon v. Newberry 132 S. E. 917, that a petition showing that the driver of a horse and wagon drove into a hole in a street 16 inches deep, 3 feet wide and 10 feet long in the daytime set out no cause of action for his resulting injuries, as he must have seen or should have seen the obvious danger.

The Georgian Court of Appeals holds, Leslie v. City of Macon, 133 S. E. 638, that where a pedestrian stepped on the foundation of a removed bridge the uneven condition of which he could not see because of its covering of muddy water, although she knew of its presence, she did not use ordinary care to avoid being injured by the city's negligence.

NO RECOVERY ALLOWED FOR PARTIAL WEAR OF CONTRACTOR'S EQUIPMENT ON BOND UNDER OKLAHOMA STATUTE

The Oklahoma Supreme Court holds, W. R. Pickering Lumber Co. v. Fuller, 244 Pac. 760, that the builder's bond provided for by Oklahoma C. E. 1921, §7486, covers all material furnished to the contractor or subcontractor on a state highway project, which is used in or consumed in the course of the project. If the consumption of the material or its value, in the manner it is applied, in connection with the construction, depends upon the period of time it is used and the extent of its use, it is not within the section, but falls within the classification of "equipment" and recovery therefor cannot be had on the builder's bond. The material involved was lumber furnished for cement forms, a temporary storage building for cement and a bin for mixing cement. It was held that recovery could not be had on the bond for the partial wear of this equipment.

PIPE TRENCH DOES NOT REQUIRE PROTECTION AGAINST ANIMALS RUNNING AT LARGE IN VIOLATION OF STOCK LAW

The Arkansas Supreme Court holds, Campbell & Hengst v. Douthit, 279 S. W. 1018, that a contractor who left a sewer pipe trench open overnight, but placed red lights along it, was not liable for injuries to a mule which fell into it, nor for negligence in failing to provide protection for animals running at large where there was a stock law in force.

PROCEEDS OF COUNTY ROAD BONDS DEPOSITED WITH BANK BECOMING INSOLVENT NOT A PREFERRED CLAIM

A county and the state of Tennessee having agreed to build a road and share the cost, the county sold bonds to raise its share and deposited the proceeds in a bank which became insolvent. If the fund belonged to the state it would be a preferential claim and the bank's assets would probably pay it in full. The Tennessee Supreme Court, Cannon County v. McConnell, 280 S. W. 24, held that in view of Laws 1917, c. 74 and other state statutes, the fund belonged to the county and therefore was not a preferred claim.

ONE PREMIUM HELD TO COVER PERIOD OF ROAD CONTRACT UNDER TERMS OF APPLICATION FOR BOND

The Rhode Island Supreme Court holds, American Surety Co., of New York v. Bristow, 131 Atl. 312, that a surety company which issues a bond to a contractor with a city for the construction of a concrete road, the application stating the amount of the bond, premium and that the contract was to be completed in 1923, the premium being paid October 22, 1921, and the contract actually completed, September, 1923, cannot collect an additional premium on the bond for the second year because the construction was not finished within one year of the writing of the bond. "By the terms of the application, the defendant agreed to pay only the premium specified."

ACCEPTANCE OF SEWER SYSTEM DID NOT RELEASE PARTIES FROM OBLIGATION UNDER CONTRACT AND BOND TO KEEP IN REPAIR

Where a sewer contractor's bond bound the principal and surety for a year after the acceptance of the work and his contract provided that the contractor should make any repairs required within that time from faulty material or workmanship and on his failure to make them the city should do so and charge the cost upon the bond, the city council did not change the terms of the bond or release the parties from their obligation thereunder by passing an ordinance accepting the sewer system. City of Aurora v. McSweeney (Mo. App.) 283 S. W. 720.

ROAD CONTRACTOR HELD NOT LIABLE FOR INJURY TO TELEPHONE LINE IN ABSENCE OF NEGLIGENCE

In an action by a telephone company against a contractor grading a state road highway for injury to telephone line, the South Dakota Supreme Court holds, Dakota Cent. Telephone Co. v. Shipman Const. Co., 207 S. Dak. 72, that the trial court erred in declining to receive evidence tending to show want of negligence and that notice was given to the telephone company of the work to be done with a request to remove its poles and wires. Neither the state nor the contractor would be liable to the telephone company for damage necessarily done to the lines without negligence in the grading work.

ROAD CONTRACTOR MUST PRESENT CLAIM TO COMMISSIONERS BEFORE SUING

Under South Dakota Nev. Code 1919, §5898, the South Dakota Supreme Court holds Roberts v. Lawrence County, 207 N. W. 104, that a contractor must present his claim for labor and materials furnished in the construction or repair of a highway to the county commissioners before suing on the claim, but may sue without appealing from their order rejecting the claim.

LIEN AGAINST MONEY DUE CONTRACTOR FOR MATERIALS SUPPLIED SUBCONTRACTOR, ALTHOUGH SUBCONTRACTOR PAID IN FULL

The New Jersey Court of Chancery holds Wills v. James, 131 Atl. 878, that, under the provisions of the New Jersey Municipal Mechanics' Lien Law, Revision of 1918, a lien may be maintained against money in the possession of a municipality and due from the municipality to a contractor by one who has supplied labor or materials to a subcontractor, even though it is made to appear that at the time the claim of lien was filed the contractor had paid the subcontractor in full.

CANCELLATION OF ROAD CONTRACT ENTERED INTO THROUGH MUTUAL MISTAKE

A road contractor sued on the ground of mutual mistake for cancellation of a contract, damages and compensation for work done on a quantum meruit basis, alleging that he made his bid on the representation that he would be called upon to remove only, approximately, 12,710 cubic yards of rock, as estimated by the engineers, whereas although the road was not completed, he had removed about 76,338.4 cubic yards of rock at great loss. The South Carolina Supreme Court held, Blassinghame v. Greenville County, 132 S. E. 616, that it was error to sustain a demurrer to the complaint on the ground that the contract was free from ambiguity, where it was alleged that the instrument was executed as a result of a mutual mistake of the contracting parties with reference to a material matter, and that the agreement would not have been entered into except for that mutual mistake; and the contractor, so alleging, was entitled to have the question raised by him submitted to the proper tribunal for determination.

MUNICIPALITY MAY BE LIABLE FOR DRAINAGE SYSTEM FOR SURFACE WATER BECOMING INADEQUATE

The Georgia Court of Appeals holds, City of Macon, v. Macon Paper Co., 132 S. E. 136, that although a system for the drainage of surface water from a city's streets may be sufficient at the time of installation, yet where, by reason of changed conditions, due to the erection of buildings which shed water into the streets, and to the construction of pavements, both of which prevent the natural seepage of water into the ground and thereby concentrate and augment the volume of water flowing through the streets, the drainage system becomes inadequate to provide for an ordinary rainfall, causing an overflow upon adjoining premises, and the situation is known to the city, its maintenance thereafter constitutes a nuisance, and the city may be liable for damages therefrom to adjacent land owners.

LEGALLY ESTABLISHED ROAD PARTLY ON RAILROAD RIGHT OF WAY

Under Kansas Rev. St. 68-703, a road hard-surfaced or otherwise improved under the benefit district plan must be on a legally established public road. When a part of such a road is situated longitudinally upon the right of way of a railroad company, and such company has, by a longtime lease at nominal rent, consented to such use of that portion of its right of way for highway purposes, it is held, Sandburg v. Board of Comrs. of Wyandotte County, Kansas Supreme Court, 245 Pac. 1029, that the statute has been sufficiently complied with to justify a refusal to enjoin the improvement of the road.

STATUTORY DUTY TO PLANK BRIDGE BEFORE CROSSING IT WITH HEAVY LOAD

The Kansas Supreme Court holds, Smith v. Kansas City, 245 Pac. 100, that damages for injury caused by a defective bridge to one passing over it with a motor truck weighing not less than five tons cannot be recovered unless it be shown and the jury find that the person injured complied with the provisions of Kansas Rev. St. 68-1129 with respect to planking such bridge before crossing it.

CITY HELD NOT LIABLE FOR NEGLIGENCE OF PUBLIC PARK EMPLOYEE

While there are cases to the contrary, the conclusion that the construction or maintenance of a public park is the exercise of a governmental function, and that the city is not liable for the negligence of its officers or employees engaged in such work, is supported by the weight of authority. The Iowa Supreme Court, Norman v. City of Charlton, 207 N. W. 134, holds that the city was not liable for the death of its employee in charge of a city grading machine, who was killed by the tractor engine operated as its motive power by another employee.

NEWS OF THE SOCIETIES

Aug. 16-19—INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Annual convention at Salt Lake City, Utah.

September—CITY MANAGERS ASSOCIATION. Fourteenth annual convention, Dubuque, Ia.

Sept. 27-29 — CANADIAN GOOD ROADS ASSOCIATION. Fourth annual convention at Niagara Falls, Ontario.

SEPT. 26-Oct. 1 — SAFETY CONGRESS, Sixteenth annual convention at Hotel Stevens, Chicago, Ill.

October 3—AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS: Annual meeting at Denver, Colo.

Oct. 17-21—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual convention at Columbus, O.

Nov. 7-9—NORTH CAROLINA SECTION, AMERICAN WATER WORKS ASSOCIATION. Annual meeting at Durham, N. C.

Nov. 14-18—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Thirty-third annual convention at Dallas, Tex.

Nov. 28-Dec. 2—ASPHALT PAVING CONFERENCE. Sixth annual conference at Atlanta, Ga.

Jan. 9-14—AMERICAN ROAD BUILDERS' ASSOCIATION. Annual convention and road show at Cleveland, O.

CONFERENCE OF STATE SANITARY ENGINEERS

The eighth annual conference of State Sanitary Engineers was held at the Hotel Sherman, Chicago, Ill., June 4-6, with an attendance of about fifty. The Saturday morning session was mainly occupied with committee reports and consideration of policy and constitutional changes. It was finally decided to change the date of the meeting to correspond with that of the American Public Health Association, but it was left to letter ballot to decide whether a meeting will be held in October, 1927, at Cincinnati, or postponed until the 1928 meeting.

Final reports were presented Saturday afternoon by the committee on the sanitary conservation of streams, W. L. Stevenson, Pennsylvania, chairman; on review, Dana E. Kepner, Colorado, chairman; and on swimming pools and bathing beaches, Stephen De M. Gage, Rhode Island, chairman. These were followed by round table discussions on the use of sodium aluminate in water purification and the standardization of chlorine tank valve connections.

A field inspection trip Sunday included visits to Grant Park, the Wenzer Dairy, Chicago University, the 68th St. pumping station and experimental plant, the new Wacker drive, the Chicago Avenue tunnel, Northwestern University, the North Side activated sludge plant and the Bowman Dairy Co.

At the Monday morning session, the report of the committee on milk sanitation, H. A. Whittaker, chairman, was presented and adopted. R. E. Irwin, assistant engineer of the Pennsylvania Department of Health, described the Electropure process of milk treatment, whereby milk is heated rapidly to about 165 degrees F. and cooled quickly, in lieu of the usual process of pasteurization. The progress report of the committee on pumps, H. F. Ferguson, Illinois, Chairman, was read by A. P. Miller, in the absence of Mr. Ferguson. F. H. Waring, Ohio, presented the report of the committee on sewage treatment, which report was commented on by W. L. Stevenson, Pennsylvania.

Final sessions were held Monday afternoon. E. S. Tisdale, West Virginia, presented the committee report on camp and outdoor sanitation, which was commented on by L. S. Finch, Indiana, E. W. Campbell, Maine, W. J. Scott, Connecticut, and W. S. Johnson, Missouri. C. M. Baker, Wisconsin, presented the committee report on ventilation. The report on sanitation of real estate developments was not presented, due to the absence of H. F. Ferguson, Illinois, chairman. The committee report on Shellfish, presented by W. J. Scott, Connecticut, was discussed at length by S. De M. Gage, Rhode Island. Mr. Tisdale presented the report of the committee on resolutions. Earnest Boyce, Kansas, discussed briefly an experience in the retardation of chlorine reaction in water.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Bancroft Gherardi, vice-president and chief engineer, American Telephone and Telegraph Company, New York City, was elected president of the American Institute of Electrical Engineers at the annual business meeting held in the Engineering Societies Building, New York, May 20 Other officers elected were: Vice-presidents, J. L. Beaver, Bethlehem, Pa.; C. O. Bickelhaupt, Atlanta, Ga.; O. J. Ferguson, Lincoln, Neb.; E. R. Northmore, Los Angeles, Calif.; A. B. Cooper, Toronto, Ont. Managers, F. C. Hanker, East Pittsburgh, Pa; H. P. Liversidge, Philadelphia, Pa.; E. B. Meyer, Newark, N. J. National treasurer, George A. Hamilton, Elizabeth, N. J. (Reelected).

These officers, together with the following hold-over officers, will constitute the board of directors for the next administrative year, beginning August 1: C. C. Chesney, Pittsfield, Mass.; M. T. Pupin, New York City; H. M. Hobart, Schenectady, N. Y.; B. G. Jamieson, Chicago, Ill.; George L. Knight, Brooklyn, N. Y.; H. H. Schoolfield, Portland, Ore.; A. E. Bettis, Kansas City, Mo.; John B. Whitehead, Baltimore, Md.; J. M. Bryant, Austin, Tex.; E. B. Merriam, Schenectady, N. Y.; M. M. Fowler, Chicago, Ill.; H. A. Kidder, New York City; E. C. Stone, Pittsburgh, Pa.; I. E. Moultrop, Boston, Mass.; H. C. Don Carlos, Toronto, Ont.; F. J. Chesterman, Pittsburgh, Pa.

The annual report of the board of directors, presented at the meeting, showed a net increase in the membership during the year of 186, the total membership on April 30 being 18,344. In addition to the three national conventions of the Institute and five regional meetings, there were 1,273 meetings held by the local organizations in the principal cities and educational institutions in the country.

NEW YORK STATE ASSOCIATION OF CITY ENGINEERS

At the conference of Mayors and other city officers of the State of New York, held at Niagara Falls, N. Y., May 31—June 2, the New York State Association of City Engineers was formed with Harry R. Hayes, Utica, president, Nelson P. Pitts, Jr., Syracuse, vice-president, and A. I. Prentiss, Binghamton, secretary.

CONFERENCE OF MAYORS AND OTHER CITY OFFICIALS OF THE STATE OF NEW YORK

At the annual conference held at Niagara Falls, N. Y., May 31—June 2, Mayor Samuel A. Carlson of Jamestown was reelected president, and W. W. Chamberlain, mayor of Johnstown, and John B. Thacher, mayor of Albany, were returned to office as vice-president and treasurer, respectively. By appointment of the State Executive Board, William P. Capes of Albany, continues as executive secretary.

NEW ENGLAND WATER WORKS ASSOCIATION

The Nominating Committee of the New England Water Works Association has announced as nominees for officers to be elected at the annual meeting: President—George A. Carpenter, city engineer, Pawtucket, R. I.; vice-president—Robert Spurr Weston, Boston, Mass.; director—George C. Brehm, city engineer and director of public works of Waltham, Mass., and Roger W. Esty, superintendent of water works, Danvers, Mass.; and treasurer—Albert L. Sawyer, water registrar, Haverhill, Mass.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Nominations for officers of the American Society of Mechanical Engineers for 1928 were announced at a recent meeting of the nominating committee held at White Sulphur Springs, W. Va. Election will be by letter ballot of the entire membership, closing on September 27, 1927.

The nominees, as presented by the regular nominating committee of the society are President, Alexander Daw, president, Detroit Edison Company, Detroit, Mich.; vice-presidents, John H. Lawrence, vice-president and engrg. manager, Thomas E. Murray, Inc., New York, N. Y.; Newell Sanders, Newell Sanders Plow Co., Chattanooga, Tenn.; Edward A. Muller, vice-president and genl. manager, King Machine Tool Co., Cincinnati, O: Paul Wright, Paul Wright & Co., Birmingham, Ala.; managers, William A. Hanley, chief engineer, Eli Lilly & Co., Indianapolis, Ind.; Luther B. McMillan, chief engineer, Johns-Manville, Inc., New York, N. Y.; Fred H. Dorner, Millwaukee, Wis.; delegates to American Engineering Council, Alex. Daw, Detroit; D. S. Kimball, Ithaca; R. C. Marshall, Washington; L. P. Alford, New York; H. V. Coes, Chicago; Wm. S. Lee, Charlotte; A. M. Greene, Jr., Princeton; David W. Brunton, Denver, and John L. Harrington, Kansas City.

AMERICAN WATER WORKS ASS'N

The 47th annual convention of the American Water Works Association was held at the Hotel Sherman, Chicago, June 6-11. About 1700 members and visitors attended the meeting, which was one of the most successful in recent years. No definite location was chosen for the 1928 meeting place, but probably the next convention will be held on the Pacific Coast. At present, San Francisco appears to be the most favored city.

Officers were elected as follows: President, James E. Gibson, manager and engineer of the Charleston, S. C., Water Department; vice-president, W. W. Brush, chief engineer, Department of Water Supply, Gas and Electricity, New York City; treasurer, George C. Gensheimer, secretary of the Water Commission, Erie, Pa.; trustees, Seth M. Van Loan, Philadelphia, and L. R. Howson, Chicago. Beekman C. Little, Rochester, N. Y., is permanent secretary.

The nominating committee also announced the nominations for 1928, as follows: President, W. W. Brush, New York City; vice-president, Jack J. Hinman, Iowa City, Ia.; trustees, C. D. Brown, Walkerville, Ont., S. H. Taylor, New Bedford, Mass., and John Chambers, Louisville, Ky.

The Diven Memorial Award, given each year to the member performing the greatest service to the Association, went to Arthur E. Gorman, chief sanitary engineer of the Department of Public Works of Chicago. The Florida Section, of which E. L. Filby is secretary, won the Nicholas Hill cup for the greatest gain in membership.

A budget of about $50,000 was adopted for the next fiscal year. There are now 15 sections, two having been added during the past year, and the membership for all grades, as of Dec. 31, 1926, was announced by Secretary Little to total 2,403.

Seventeen business sessions were held, including the division meetings of plant operation and water purification men. Committee reports were noticeably absent, but there were well-attended meetings of the committee on boiler feed waters. The entertainment program was well carried out, but the death of C. R. Wood of R. D. Wood & Co., Philadelphia, cast a shadow over the remainder of the program, and the smoker planned by the Water Works Manufacturers' Association was cancelled.

A meeting was held Saturday morning, June 11, to discuss the subject of the formation of a sewage section in the Association. About 75 men attended this meeting. One of the objects of the meeting was to find a place for publication of sewage papers, which, it was stated, now lack an outlet. After an extended discussion, in which the various associations now having an interest in sewage work were reviewed, it was stated by Abel Wolman, editor of the *Journal of the American Water Works Association*, that the present budget would not allow for the publication of all water papers now available, and that the association membership does not now take in nearly all eligible water works men. It was deemed advisable, therefore, to confine the activities of the association to the water works field. A committee was voted, to be appointed by C. A. Emerson, Jr., to arrange an open conference at the convention at Cincinnati in October of the American Public Health Association.

PERSONALS

Charles R. Wood, president of R. D. Wood & Co., died suddenly of a heart attack on June 8, aged 56 years. He was attending the convention of the American Water Works Association, of which he had for years been an active and highly esteemed member, and his death came as a shock to the convention. Besides this society he was a member of the A. S. M. E., the A. S. T. M., the A. I. & S. I., and the A. I. M. & M. E. Since 1901 he advanced from sales manager and engineer to president of R. D. Wood & Co. He invented a hydrant nozzle cut-off and other hydrant improvements.

John M. Goodell, for many years editor of "Engineering Record," died June 21 in New York City. At different periods he had also been editor of the Journal of the American Water Works Association, associate editor of "Engineering News," assistant secretary of the American Society of Civil Engineers, and consulting engineer to the Bureau of Public Roads. During the war he was employment manager of the emergency fleet corporation and during the last months acting chairman of the National Highway Council. He was born at Worcester, Mass., in 1867, and in 1888 graduated from the Worcester Polytechnic Institute.

L. W. Lemon has resigned as city engineer of Centralia, Illinois, to become city manager of Paris, Ill.

Robert Cramer, for the past four years a member of the Milwaukee, Wis., Sewerage Commission, has been appointed its chief engineer, succeeding T. Chalkley Hatton, who resigned Dec. 31, 1926.

T. Chalkley Hatton, who recently resigned as chief engineer of the Milwaukee sewerage commission, has opened an office as consulting engineer at 490 Broadway, Milwaukee.

N. Adelbert Brown, for twenty years in the Rochester, N. Y., city engineer's office and since 1923 with Bartlett-Snow company, died May 21 at Birmingham, Ala., where he was representing that company.

O. L. Hemphill, formerly state highway engineer of Arkansas, resigned this position on May 1.

Nelson I. Raymond has been appointed city engineer of Owosso, Mich.

Scott E. McCullough, for eight years assistant city engineer of Bloomington, Ill., became city engineer on May 2.

TRADE PUBLICATIONS

Inundation.. Mechanical control of Water-Cement Ratio and Production of Constant Concrete. The Blaw-Knox Co., Pittsburgh, Pa 36 pp. Ill.

Proper control of the water-cement ratio is now recognized as a necessity in the production of constant concrete. In this booklet, the Blaw-Knox Co. has made plain the problems to be solved, the benefits to be derived, and the methods of procedure. Blaw-Knox equipment is described.

Celite for Concrete. Celite Products Co., Los Angeles, Calif., 16 pp. Ill. This bulletin (No. 375-B) gives up-to-date information on the use of Celite in concrete, including a discussion of the use of Celite where the water-cement ratio is specified. There are also given data of interest on concrete construction, with particular reference to the effect of workability on uniformity, strength, waterlightness, permanence and appearance of the concrete.

Novo Hoisting Handbook. Novo Engine Co., Lansing, Mich. 44 pp. Ill. The second edition of this valuable booklet. Twelve pages, and much new material have been added. It covers well, though briefly, the entire field of construction and plant hoisting.

NEW BOOKS

Highway Administration and Finance. By Thomas R. Agg and John E. Brindley. McGraw-Hill Book Co. 382 pages, 20 ills. $4.

This book starts with two very interesting chapters on the history of national, state and local highway administration, following these with an outline of the development of highway administrations and highway systems. Highway finance is discussed at some length and in an interesting manner. Other chapters include data regarding the technical functions of highway departments, organization, contract and day labor construction, instructions and reports, and civil service. Of interest to highway engineers should be the discussion of the field of highway engineering, the compensation in the various branches, and minimum specification for positions.

Portland Cement Concrete of Unusual Character. Bulletin No. 23, Kansas City Testing Laboratory. 18 pp. Ill.

This booklet gives in concise form data on waterproofing, prevention of freezing during hardening, quick hardening, improved workability, light weight, fireproofing, heat insulation, sound proofing and prevention of parasitic growths.

CIVIL SERVICE EXAMINATIONS

JUNIOR DECK OFFICER

Applications to July 29. To fill vacancies in Coast and Geodetic Survey and positions requiring similar qualifications. Entrance salary $2,000. After six months service applicants are eligible for promotion to lower commissioned grades.

NEW CATALOGS

GRADERS AND DUMP WAGONS.
J. D. Adams Co., Indianapolis, Ind. A 24-page illustrated catalog describing Stroud elevating graders and dump wagons.

GARBAGE INCINERATORS.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. A 12-page illustrated folder describing the advantages and details of construction of the United States standard garbage incinerator.

MUNICIPAL WATERWORKS.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. A 48-page catalog illustrating some of the waterworks installations made by this company, and giving data on standard sizes of tanks and towers.

ELECTRIC FLOW METERS.
Brown Instrument Co., Philadelphia, Pa. 62-page illustrated catalog describing Brown meters of all kinds. Also a 4-page folder illustrating and describing Brown thermometers and pyrometers.

WELDING EQUIPMENT.
Smith Welding Equipment Corp., Minneapolis, Minn. A 32-page illustrated catalog describing the welding and cutting equipment manufactured by this company.

NEW TRACKSON CIRCULAR.
Trackson Co., Milwaukee, Wis. The "Model D" circular, describing the new heavy-duty model Trackson Full-Crawler which is now in production.

MOTOR TRUCKS.
Relay Motors Corporation, Wabash, Ind. A 4-page folder illustrating Commerce relay drive motor trucks.

STEEL COATING.
Hill, Hubbell & Co., San Francisco, Cal. Illustrated looseleaf catalog on Modern Practice in Tank Protection. Illustrated looseleaf catalog on Pipe Protection.

ROAD MACHINERY.
J. D. Adams & Company, Indianapolis, Ind. 56-page Illustrated catalog showing entire line of maintainers, graders, and other road-building equipment.

LIGHTING EQUIPMENT
The General Electric Co., Schenectady, N. Y. A 36-page illustrated catalog describing street lighting transformers, and an 8-page illustrated catalog of Novalux Ornamental Units.

GENERAL EXCAVATOR
The General Excavator Co., Marion, O. Bullein No. 2703. A 12 page illustrated catalog describing in detail the general excavator.

Marion Steam Shovel Co., Marion, O. An illustrated folder of the Type 7 Steam Shovel.

Galion Iron Works & Mfg. Co., Galion, O. An illustrated folder showing Galion road building equipment.

The Graver Corp., East Chicago, Ind. A 16-page illustrated bulletin describing the Los Angeles, Calif., municipal swimming pools, all of which are equipped with Graver filters.

Edison Lamp Works, General Electric Co., Harrison, N. J. A 28-page illustrated bulletin on lighting data, with information on street traffic control. Also bulletin LD 155, Illumination Terms, a 56-page illustrated booklet on terms used in lighting nomenclature.

Otis Engine Corporation, New York, N. Y. A 4-page illustrated folder describing the Otis Revolving Hammerhead Crane.

International Cement Corporation, N. Y. A 24-page illustrated booklet describing the various plants of the International Cement Corporation.

General Electric Co., Schenectady, N. Y. A 26-page illustrated catalog describing Novalux Traffic Signals.

Interflash Signal Corporation, New York, N. Y. A 4-page, 2-color folder illustrating traffic signals.

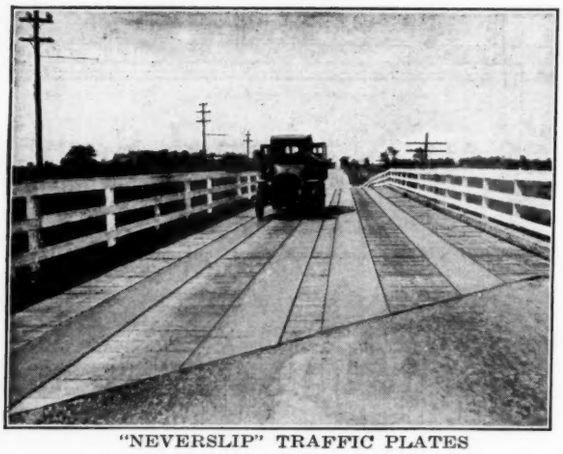
(*Continued on page* 44)

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

NEVERSLIP TRAFFIC PLATES

The American Pressed Steel Co. Philadelphia, Pa., manufactures Neverslip Traffic Plates, which are of especial value for covering the planking on bridges. They are placed in lanes, spaced the normal gauge for vehicles, and may be laid directly on worn planking, thus eliminating the need for reflooring, and affording a durable nonslipping surface which tends to distribute heavy unit loads over a greater area. It is desirable to coat the under sides of the plates with a preservative paint before placing. The plates are about 24 inches wide, and are furnished 12 feet to 20 feet in length. Two lanes should be provided for one-way bridges, and three or four lanes for two-way bridges.



"NEVERSLIP" TRAFFIC PLATES

NOVO COMBINATION HOIST AND COMPRESSOR

The Novo Engine Co., Lansing, Mich., has developed a combination hoist and air compressor unit to meet the requirements of erection jobs where heavy equipment is not practicable or economical.

The use of this combination eliminates the necessity of having a separate air compressor unit for running the air tools essential in steel construction work, and requires only one engine to run both the hoist and compressor. The machine is mounted on a common frame, the engine being placed between the hoist on one end, and the compressor on the other end of the frame. The units are furnished truck or skid mounted, either single or double drum type, and with or without air receiver. The initial cost of the combination is less than the initial cost of two separate units. In addition, the expense of running the combination unit, with but one operator, is stated to be about half of that incurred in running two separate units.

NOVO COMBINED HOIST AND COMPRESSOR

LAKEWOOD WORM SPEED REDUCTION MIXER

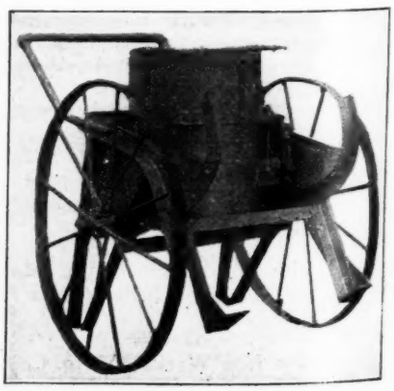
The Lakewood Engineering Co., Cleveland, O., has brought out a new worm speed reduction mixer, size 10-S, A.G.C. rating. The principal driving mechanism is a heat treated steel worm mounted on large Gurney ball bearings and direct connected to either a gasoline engine or electric motor. It drives a solid bronze worm gear which is keyed to the drum pinion shaft, this shaft also is carried in Gurney ball bearings.

The worm, worm gear and bearings are enclosed in a dust-proof housing and run in oil at all times, eliminating the open spur gear reduction formerly used for this purpose. The all-steel plate drum is mounted on drum rollers which are chilled tread, ground to accurate surface and run in Hyatt roller bearings. The drum roller shaft is super case-hardened steel and mounted in self-aligning cast bearings. This construction makes for minimum friction; smoother operation; and longer life. The power loader skip, batch hopper and discharge chute all have a 50 degree discharge angle, assuring clean, fast charging and discharging. The pivoted power loader is equipped with automatic knockout and all levers are banked for one man operation. The use of the worm speed reduction makes all parts of the engine as well as parts of the mixer easily accessible for adjustment. Alemite lubrication is used throughout.

LAKEWOOD WORM SPEED REDUCTION MIXER

BLAW-KNOX JUNIOR INUNDATOR

The Blaw-Knox Co., Pittsburgh, Pa., has developed the Junior Inundator to measure sand and water to accommodate automatically the variable moisture content in the sand, and, at the same time,



BLAW KNOX JUNIOR INUNDATOR

CALUMET AVENUE, CALUMET MICH. a part of Michigan State Highway No. 15, was paved in 1920 with asphalt macadam. The asphalt used in the construction was

Stanolind Paving Asphalt

There has been no maintenance on this pavement since it was laid. The above photograph shows that seven years of heavy use have not damaged it in the least

For long service and low maintenance cost, use Stanolind Paving Asphalt

STANDARD OIL COMPANY
(INDIANA)

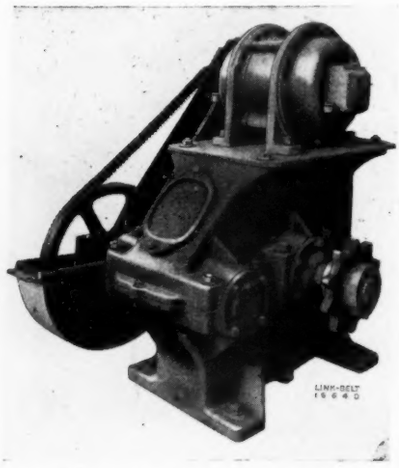
General Offices: 910 S. Michigan Avenue CHICAGO, ILLINOIS

ILLINOIS	INDIANA	IOWA	S. DAKOTA	N. DAKOTA	Milwaukee	MISSOURI
Chicago	Evansville	Davenport	Huron	Fargo	Green Bay	Kansas City
Decatur	Indianapolis	Des Moines	MICHIGAN	Minot	MINNESOTA	St. Joseph
Joliet	South Bend	Mason City	Detroit	WISCONSIN	Duluth	St. Louis
Peoria	KANSAS	Sioux City	Grand Rapids	La Crosse	Mankato	
Quincy	Wichita		Saginaw		Minneapolis	

eliminate automatically any further variable by compensating for moist sand bulking. This machine is claimed to provide an easy and positive way of producing constant concrete. It requires no change in the rest of the equipment used on the job.

CALDWELL SPEED REDUCER

The H. W. Caldwell & Son Co., Chicago, Ill., announces a new speed reducer, which is made in two styles, A and B, the latter being especially designed for driving screw conveyors while Type A is for general industrial uses. Each reducer is a self-contained unit, entirely enclosed, and occupies very little space. Two separate drives are combined, a Link-Belt silent chain drive



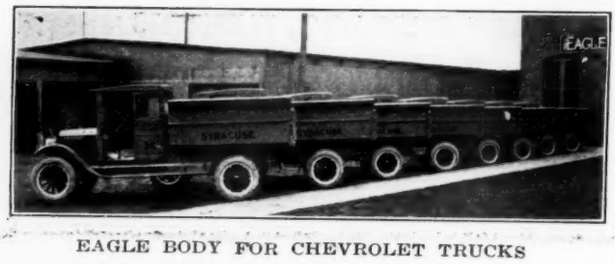
CALDWELL SPEED REDUCER

from the high speed shaft, and a cut spur gear drive to the low speed shaft. It is made in sizes to furnish ratios from 7:1 to 40:1 in Type A, and 30:1 in type B. With this speed reducer it is not necessary to use a flexible coupling on the motor shaft, since the silent chain drive provides the necessary flexibility.

EAGLE BODIES FOR CHEVROLET TRUCKS

The Eagle Wagon Works, Auburn, N. Y., manufactures a special size body, 86-C, which is especially adapted for use with Chevrolet trucks. This body is of the hand hoist dump type, of large capacity, designed especially for use in handling such bulky materials as waste paper, leaves, and refuse. With extra 6-inch by 12-inch flaring side boards, the capacity is 110 cubic feet. Without the flare, the body is 65 inches wide, 84 inches long, and 16 inches deep. The loading height is 55 inches and dumping clearance 24 inches. The body weighs 900 pounds.

A recent delivery of eight of these bodies and eight open cabs on Chevrolet trucks was made to the Public Works Department of Syracuse, N. Y.



EAGLE BODY FOR CHEVROLET TRUCKS

ELECTRIC SIGNAL PANEL

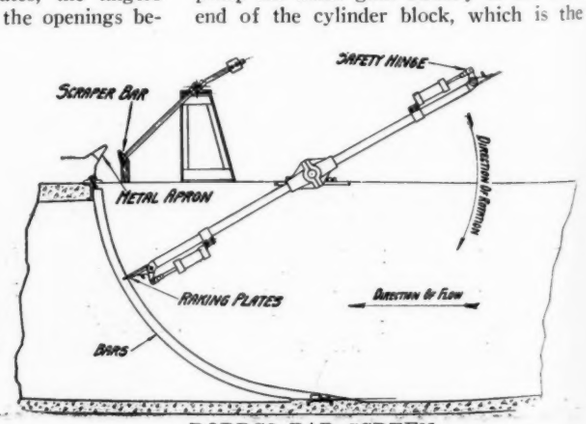
The General Electric Co., Schenectady, N. Y., announce a new signal panel, the CR-4779-A-1, which has been designed for pump installations as a warning signal for the purpose of calling an attendant in case of danger from overflow or emptying of the tank. The panel is governed by one or two float switches.

With this panel an audible signal sounds immediately when either the pre-determined high or low level of water is reached. The gong can be silenced by the attendant upon his arrival, and the silencing switch does not have to be manually reset after the float switch takes a normal position. "High" and "low" signal lamps are provided, either of which lights when the pre-determined level has been reached, remaining lit until the float takes a normal position.

The panel can be used for a one-level signal by omitting the float switch for the other level. It can also be used on pressure systems but, when single-pole float or pressure switches are used, it is necessary to add a relay in place of the other pole.

DORRCO BAR SCREEN

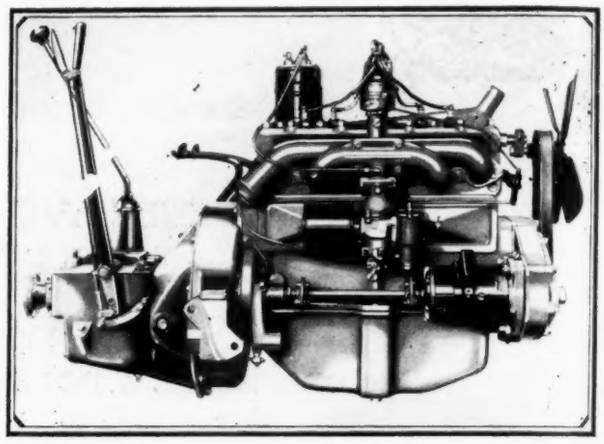
The Dorr Co., New York, have developed the Dorrco Bar Screen which, it is stated, can be kept clean mechanically, but does not require a skilled mechanic for operation. This screen consists of bars curved in the form of a quadrant, so placed that the incoming sewage flows against the concave side. The openings between the bars depends on local conditions and the character of the sewage. The cleaning mechanism consists of two parallel arms joined at each end by raking plates, the fingers of which dove-tail into the openings between the bars. This mechanism, driven by motor and speed reducer, swings about its long axis. As it swings, the raking plates sweep up the solids from the bars, squeeze out the excess moisture, and deposit the screenings on a plate. Simplicity, reliability and positive action, with a minimum of attention and care are claimed.



DORRCO BAR SCREEN

NEW ENGINE IN GRAHAM BROS. TRUCK

Graham Bros., Detroit, Mich., is now using in all its trucks the new Dodge motor which, it is claimed, represents radical improvements in acceleration,



NEW MOTOR USED IN GRAHAM BROS. TRUCKS

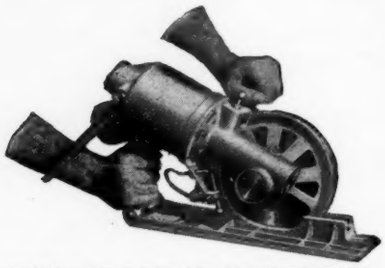
speed, power, and economy. Graham Brothers trucks and commercial cars are made in ¾, 1, 1½ and 2-ton models to serve all transportation requirements.

The new engine is fitted with a heavy-duty transmission and a large single plate clutch, both designed for truck service. While the engine is a new design, the bore and stroke dimensions and other elements of the one it replaces are retained. The large chrome-vanadium steel crankshaft with five main bearings and the highly efficient two-unit starter-generator system, introduced during the last year in all Dodge Brothers engines, are essential features. The distributor is mounted on top of the engine, thus eliminating the possibility of trouble from water and dirt which might enter through the radiator or the louvres in the sides of the hood. The location of the water pump has been improved by placing it at the rear of the engine. From the pump the water goes directly to the rear end of the cylinder block, which is the

hottest part. From there, it flows forward to the radiator where it is again cooled. The long hand brake lever has been fitted with double ratchet and improved release and is exceptionally convenient for quick action by the driver.

WALLACE PORTABLE ELECTRIC HANDSAW

J. D. Wallace & Co., Chicago, Ill., has recently brought out a portable electric hand saw which is claimed to be of especial value in cutting timber for concrete forms and other building operations. Either alternating or direct current may be used. The machine is claimed to be safe, since the blade is covered and the guard locked except when in use. An 8-inch standard saw is used. Ball bearings are used throughout and all gears run in grease.



WALLACE PORTABLE HAND SAW

INDUSTRIAL NOTES

HARNISCHFEGER MOVES DALLAS OFFICE

Harnischfeger Corporation, Milwaukee, Wis., has removed its Dallas, Tex., office from the Fidelity Union Building to the Construction Industries Building.

ANDREWS-BRADSHAW CO.

Andrews-Bradshaw Co., Pittsburgh, Pa., manufacturer of Tracyfier, announces the appointment of R. N. Robertson as chief engineer, and A. L. Menzin as director of research.

CHICAGO BRIDGE AND IRON WORKS

The city of Springfield, Ill., has contracted with the Chicago Bridge and Iron Works for the fabrication and erection of a one-million gallon Horton Ellipsoidal-bottom elevated steel water tank. The tank, which will be 72 feet in diameter, 41. feet from bottom to top, will be placed on a steel tower 83 feet high. It will be the largest steel elevated water tank in Illinois.

CLIMAX ENGINEERING CO.

Edward C. Dingman, Montreal dealer of the Climax Engineering Company, Clinton, Iowa, has moved his office from the Keefer Building to 1120 Castle Building, 1410 Stanley Street.

Additions to the sales force of the Climax Engineering Co. included H. P. McCullough, 328 Chronicle Bldg., Houston, Texas; E. H. Crippen, 4023 W. 7th St., Fort Worth, Tex., and the James McGraw Co., Richmond, Va.

LINK-BELT BUILDS NEW FACTORY

Link-Belt, Ltd., has under construction at Toronto, Can., a new factory. Jackson-Lewis Co., Ltd., Toronto, are general contractors. Ewart, Armer & Byram are engineers in charge of the work.

GENERAL ELECTRIC CO. NOTES

In conformity with the action of the board of directors of the General Electric Company, an engineering council has been appointed. The council includes E. W. Rice, Jr., honorary chairman (ex-officio); E. W. Allen, chairman; Elihu Thomson, A. C. Davis, W. R. Whitney, W. L. R. Emmet, C. C. Chesney and C. E. Eveleth.

The General Electric Company has announced a five per cent reduction in prices of distribution transformers and small power transformers, effective June 1st. This reduction is the sixth since 1920. On certain types of large transformers, reductions which average five per cent for this class of product have also been made. These reductions are made possible, it is stated, by economies resulting from improved engineering and manufacturing methods, and standardization.

PORTLAND CEMENT ASSOCIATION MONTANA OFFICE

The Portland Cement Association has opened an office in Helena, Montana, in charge of A. L. Strong, district engineer. Mr. Strong has been on the district office staff of the Association at Yakima and Seattle, Washington, since 1920. Prior to this he had been engaged for ten years in city and county engineering.

ALABAMA DU PONT PLANT

The new dynamite plant of E. I. du Pont de Nemours & Company at Mineral Springs, a short distance from Birmingham, Ala., has begun the actual manufacture of dynamite. This is the largest dynamite plant in the South and has an annual capacity of 15,000,000 pounds. It is contained within an area of 1,280 acres and comprises some fifty separate buildings of the most modern type for this kind of manufacture and equipped with the latest machinery.

NATIONAL PAVING BRICK MFRS. ASS'N. MOVES.

The National Paving Brick Mfrs. Ass'n. has removed its offices from Cleveland, O., to 332 So. Michigan Ave., Chicago, Ill.

BARBER-GREENE MODELS

A feature of the Barber-Greene exhibit at the American Waterworks Association convention was the electrically driven model, complete in all parts, of the Barber-Greene ditcher.

LINK-BELT CO. CHANGES

R. P. Shimmin has been appointed assistant to the chairman and the president of the Link-Belt Co., Chicago, and Frank B. Caldwell has been made sales manager of the Western division.

DETROIT BUREAU OF GOVERNMENTAL RESEARCH, INC.

The Detroit Bureau of Governmental Research, Inc., has moved from 316 Jefferson Ave., East, to 51 Warren Ave., West, Detroit, Mich.

NEW CATALOGS

(Continued from page 39)

Macomber Steel Co., Canton, O. An 8-page illustrated catalog describing Massillon standardized steel building products.

Cyclone Fence Co., Waukegan, Ill. Report on tests of Cyclone Road Guard made at University of Illinois. 20 pages. Ill.

Youngstown Boiler and Tank Co., Youngstown, O. Bulletin 500. A 40-page illustrated catalog, showing a large variety of types of tanks.

Russell Grader Manufacturing Co., Minneapolis, Minn. A 50-page illustrated catalog of Russell graders and road machines, including plows, scrapers, screens, drags and conveyers.

W. & L. E. Gurley, Troy, N. Y. An illustrated, 19-page catalog describing Gurley transits, levels and other scientific equipment.

Blaw-Knox Co., Pittsburgh, Pa. A 36-page illustrated catalog of Inundation and Central Mixing Products.

Link-Belt Co., Chicago, Ill. Elevators and conveyors, book No. 575. 96 pages. Illustrated.

Walter Motor Truck Co., Inc, Long Island City, N. Y. A 16-page illustrated catalog describing Walters snow fighting equipment.

Link-Belt Co., Chicago, Ill. The Power Hoe. 16 pages. Illustrated.

The Buhl Co., Chicago, Ill. A 12-page illustrated catalog No. 104-C describing the portable air compressor.

The Huber Mfg. Co., Marion, Ohio. A 24-page illustrated catalog describing the Huber Motor Roller.

American Pressed Steel Co., Philadelphia, Pa. A 4-page illustrated folder describing Neverslip traffic plates for bridges.

Jaeger Machine Co., Columbus, O. An 8-page folder, illustrated with blue prints, and giving specifications of Jaeger mixers.

General Electric Co., West Lynn, Mass. Motor Dealer's Power Manual. 20 pages. Ill.

Portable Machinery Co., Clifton, N. J. A 32-page illustrated catalog of portable conveyors, loaders, etc.